

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



#19

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> :	A1	(11) International Publication Number:	WO 98/25377
H04L 12/24		(43) International Publication Date:	11 June 1998 (11.06.98)

(21) International Application Number: PCT/CA97/00953

(22) International Filing Date: 5 December 1997 (05.12.97)

(30) Priority Data:  
08/764,086 6 December 1996 (06.12.96) US

(71) Applicant: NORTHERN TELECOM LIMITED [CA/CA];  
P.O. Box 6123, Station A, Montreal, Quebec H3C 3J5 (CA).

(72) Inventors: PLANAS, Miguel, Alberto; 3 Elmdale Lane,  
Ottawa, Ontario K1M 0G2 (CA). TALBOTT, Doug,  
Edward; 64 Kingsford Court, Kanata, Ontario K2K 1T9  
(CA).

(74) Agents: BRETT, R., Allan et al.; Smart & Biggar, 900-55  
Metcalfe Street, P.O. Box 2999, Station D, Ottawa, Ontario  
K1P 5Y6 (CA).

(81) Designated States: CA, JP, European patent (AT, BE, CH, DE,  
DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

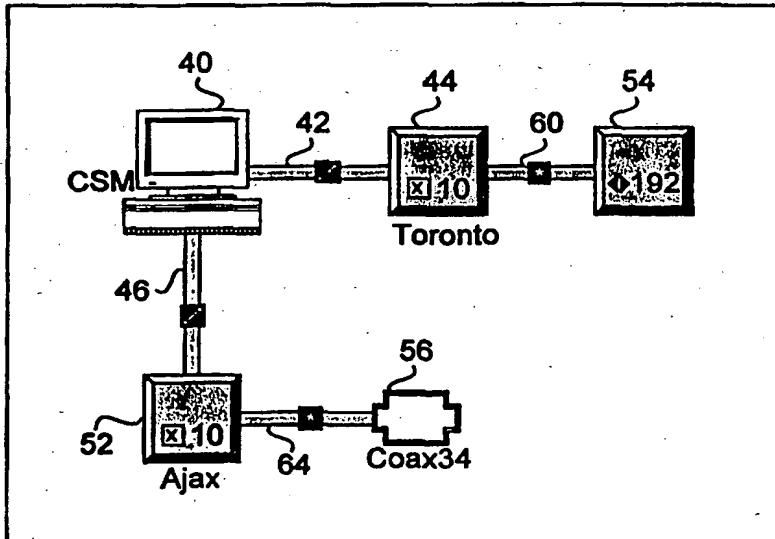
Published

*With international search report.*

(54) Title: NETWORK MANAGEMENT GRAPHICAL USER INTERFACE

(57) Abstract

A method is provided for graphically depicting detailed state and status information for network objects, particularly network objects forming part of a telecommunications network. A graphical representation of a network is displayed in which a basic icon is displayed for each network object. More commonly occurring state and status combinations are conveyed by imparting attributes to the basic icons such as dashed, solid, or three-dimensional outlines. Less commonly occurring state and status combinations are conveyed by attaching modifier icons to the basic icons. The method is particularly suited to providing a detailed visual representation of the states and statuses included in the OSI standard.



**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		

## NETWORK MANAGEMENT GRAPHICAL USER INTERFACE

## Field of the Invention

The invention relates to network management, and more particularly to a graphical user interface suitable for use in the management of large telecommunications networks.

## Background of the Invention

It is common to employ one of many existing network management tools to manage computer and/or telecommunications networks. These tools typically run on PC or UNIX workstations. In the telecommunications context, network management tools enable the maintenance, surveillance and administration of the multiple telecommunication devices which make up the network. Tasks performed by these network management tools through a network management interface include alarm monitoring, test and diagnosis of faults, performance monitoring and connection management.

An objective of most network management tools is to provide a centralized view of the network so as to enable the correlation of events and conditions that span network elements and subnetworks. A further objective is to facilitate the management of a network consisting of a non-homogeneous collection of telecommunication devices. Some existing network management tools provide GUI (graphical user interface) access to the users. An example of a data network management tool which provides GUI access to users is HP Open view. This tool and its associated GUI is appropriate for the management of data networks in which a set of relatively simple nodes may be complexly meshed. The nodes are simple in the sense that from the network management perspective, they can be in only one of a very small number of states. This tool and others like it

are not appropriate for the management of even simple telecommunications networks which include nodes which are very complex. Telecommunications nodes are complex in the sense that from the network management perspective, they can 5 simultaneously be in one or more of a large number of states.

There exist Bellcore and ISO (International Standards Organization) standards which include OSI (Open Systems Interconnect) standards which specify a set of generic states network objects forming part of a telecommunications network 10 can be in. Network objects are products produced by a variety of different vendors and include nodes, links and shelf based equipment. The intent of the generic states is to allow network objects which are compliant with these standards to be maintainable remotely by non-vendor specific network management 15 tools. These standards provide a textual definition to the states but the graphical representation of the permutations and combinations of these states is left up to network management tool developers. This opens the door to very complex and cluttered visual displays or more commonly to the 20 superimposition of acronym subscripts and superscripts on top of the visual displays to avoid confusion. These standards are meant to be applied to most telecommunication network objects. Prior art network management GUI tools have not incorporated the full OSI and BellCore state models or have failed to do so 25 in a manner which efficiently expresses them in a simple visual language which does not consume excessive space in the windows on a screen. The common approach is for such tools to address only a subset of the aforementioned standards, and to create new arbitrary "meta-states" that represent combinations of 30 states.

The specific ISO standards and Bellcore requirements which are applicable are of course subject to change over time.

At this time the relevant ISO standard is : ISO/IEC 10164-2, Information Technology - Open Systems Interconnection - System Management - Part 2, State Management Function (for CCITT Applications) CCITT Rec.X.731 (now ITU-T).

5 Bellcore requirement is: Generic Requirements GR-1093-CORE, Issue 1 Oct.1994 & Revision 1 Dec. 1995, Bellcore, Generic State Requirements for Network Elements.

10 Summary of the Invention

It is an object of the invention to provide an improved network management GUI.

This invention is concerned with a GUI language used to perform network management of telecommunications networks.

15 According to a first broad aspect, the invention provides a processor implemented method for displaying information relating to a telecommunications network consisting of a plurality of network objects using a network management terminal having a display, the information consisting of a base state for at least one of the network objects, the method comprising the steps of: displaying on the display for each network object a basic icon corresponding to that network object; imparting to the display of each said at least one basic icon an attribute representative of the base state of the 20 corresponding network object.

25 According to a second broad aspect, the invention provides a method for displaying OSI state and status information relating to a telecommunications network consisting of a plurality of network objects using a network management terminal having a display and processing means, the method comprising the steps of: the processing means converting the 30 OSI state and status information into base states and

supplementary states for each network object; the processing means displaying on the display for each network object a basic icon representative of that network object, the basic icon being a node icon for a node network object, a card icon for a card network object, and a link icon for a link network object; imparting to the display of at least one basic icon at least one attribute selected from a predetermined set of possible attributes; adding to the display of each basic icon zero or more modifier icons selected from a predetermined set of possible modifier icons;

wherein each attribute is representative of a different predetermined base state; wherein each modifier icon is representative of a different predetermined supplementary state.

According to a third broad aspect, the invention provides a system for monitoring a telecommunications network consisting of a plurality of network objects, the system consisting of: a network management terminal having a display and processing means; means for conveying network management information from the network to the network management terminal; wherein the processing means displays on the display for each network object a basic icon representative of that network object; wherein the processing means converts the network management information into a base state for each of at least one network object; wherein the processing means imparts to each basic icon representative of said at least one network object at least one attribute selected from a predetermined set of possible attributes; wherein each attribute is representative of a different predetermined base state.

30

#### Brief Description of the Drawings

Preferred embodiments of the invention will now be

described with reference to the attached drawings in which:

Figure 1 is a context diagram for the application of the invention;

5 Figures 2a - 2d illustrate three different types of basic network element icons;

Figure 2e illustrates a symbol set for identifying classes of network icons;

Figure 2f illustrates several network element icons identified with symbols from the set illustrated in Figure 2e;

10 Figure 2g illustrates several link icons;

Figure 3 illustrates a pictorial icon;

Figure 4a is an example representation of a simple network using the symbols and icons of Figures 1 to 3;

15 Figure 4b is an example representation of a network including container icons;

Figure 4c is an example representation of a network including translucent container icons displayed over a map;

Figure 4d illustrates an example of several container icons that have interlocking shapes;

20 Figure 5 illustrates network icons in each of three base states;

Figure 6 illustrates network icons in the usage state "Busy", and the Administrative states "Locked" and "Shutting Down";

25 Figure 7 illustrates a node icon, a link icon, and a card icon in each of the three base states;

Figure 8 illustrates modifier icons identifying the Procedural status;

30 Figure 9 illustrates modifier icons identifying the Availability status;

Figure 10 illustrates modifier icons identifying the Control status;

Figure 11 illustrates modifier icons identifying the Standby status;

Figure 12 illustrates the simultaneous display of states and statuses;

5 Figure 13 illustrates the positioning of modifier icons on link icons;

Figure 14 illustrates the positioning of modifier icons on card icons;

10 Figure 15 illustrates an example of a selectable modifier icon;

Figure 16 illustrates modifier icons identifying the Alarm status;

Figure 17 illustrates further details of New alarm modifier icons;

15 Figure 18 illustrates the depiction of outstanding alarms and alarms which are under repair;

Figure 19 illustrates an example of the graphical depiction of a typical series of state and status transitions which might occur during an alarm scenario;

20 Figure 20 is a flowchart for the steps taken to update the states and statuses depicted in a graphical representation of a network;

Figure 21a - 21f illustrate an example usage scenario; and

25 Figure 22 illustrates node icons which may be expanded to display additional information.

#### Detailed Description of the Preferred Embodiments

A telecommunications network consists of an 30 interconnected set of network objects. There are three basic types of network objects, these being (1) network elements or nodes, (2) links, and (3) individual cards in a piece of shelf-

based equipment.

Examples of network elements or nodes include voice switches, packet switches, cross connects, ATM (Asynchronous Transfer Mode) switches, ATM access and transport nodes.

5 Network elements include shelf-based equipment located in a telecommunications company central office such as an ATM Concorde or OC192 ADM (Add-Drop Multiplexer) and field based equipment such as a coaxial node. A network element which is shelf-based is composed of a set of circuit cards installed in 10 one or more shelves. An individual card in one of these shelves is also considered a network object. In this case, the piece of shelf-based equipment as a whole is a considered a network object, and at the same time each individual card in the shelf-based equipment is a network object.

15 Links connect nodes together and include copper wire links, microwave links, satellite links, coaxial links and optical fibre links for example. In some instances, repeaters may also be considered to be part of a link.

Additional components may be connected to the network 20 which are used to manage the telecommunications network. Examples include databases, operating systems, terminals and printers. These components are not network objects, and do not form part of the telecommunications network per se.

Figure 1 shows a physical context for the application 25 of the present invention. There is a telecommunications network 2 consisting of a number of nodes or switches 3 and a number of links or transmission systems 4. The main network traffic consists of data or voice signals on the transmission systems 4 between the switches 3. Subscribers may access the 30 network 2 with devices such as telephones 5 or personal computers 6 equipped with modems. In addition, there is managing equipment consisting of operations systems devices 7

and workstations 8 connected to a data communications network 9. The data communication network 9 includes a connection 10 to each of the switches 3(nodes) and transmission systems 4(links) in the telecommunications network 2. Management 5 traffic flows on the data communications network 9 between the switches 3 and the managing equipment 7,8, the management traffic consisting of information for monitoring and controlling the network. The management traffic flows on the data communications network according to a communications 10 protocol P which allows the switches and the management equipment devices 7,8 to understand each other. The interface between one of the network management devices 7,8 and the telecommunications network 2 may be referred to as a network management interface. The network management traffic may 15 include state and status information for the switches 3(nodes) and transmission systems 4(links), and may also contain test, or traffic information for example. One or more of the management equipment devices 7,8 runs a network management GUI according to the invention and these management equipment 20 devices will be referred to as network management terminals. These GUI equipped network management terminals have access to and in some cases control over network management information. A processor (not shown) forming part of each network management terminal receives the network management information, processes 25 it, and presents it graphically on a display (not shown) with the GUI according to the invention. The invention provides a top level graphical view of the network objects which make up a network, and at the same time shows detailed state and status information for each network object. This gives network 30 operators the ability to quickly visually interpret the state of the network at any time.

In the graphical representation of a network

- 9 -

according to the invention, a basic icon is used to represent each network object. Icon attributes may be imparted to a basic icon to display state and status information for the network object represented by the basic icon. Icon attributes 5 may include various icon outlines, shadings or three dimensional appearances as applied within the border or perimeter of the basic icon, for example. Further state and status information is displayed by attaching modifier icons to the basic icon. The various basic icons will be described with 10 reference to Figures 1 to 4, and the manner in which state and status information is added to these icons will be described with reference to Figures 5 to 19.

A different basic icon shape is used to represent each of the three types of network object, namely nodes, links, 15 and cards within a shelf. Referring now to Figure 2a, a basic icon is shown which consists of a light grey coloured square icon used to represent a node. This will be referred to as a node icon. Identification symbols and numbers may be added to the basic icon to identify the type and capacity of the node it represents. A preferred set of identification symbols which 20 includes some symbols recommended by the ITU-T is shown in Figure 2e and several node icons identified with these symbols are shown in Figure 2f. Referring to Figure 2e, the ITU-T (International Telecommunications Union-Telecommunications 25 Standardization Sector) based symbols include a square encompassing an "X" 12 representing a switch or a cross connect, a solid diamond 13 representing a transport node, a pair of solid triangles 14 representing a transport add-drop multiplexer, and a diamond separated into four squares 15 30 representing a transport cross connect. Suggested new symbols include a triangle with a series of parallel lines 16 representing an access node, a diamond which is solid except

for a square hole in its centre 17 representing a regenerator, a diamond with a vertical slot in its bottom half to represent an LTE (line terminating equipment) and a question mark symbol 19 to represent an unknown network element. In some 5 circumstances a symbolic node icon may be used which differs from the square icon depicted in Figure 2a so as to be more representative of the node it represents.

Referring now to Figure 2f, several examples of node icons for network elements are shown. Node icon 20 includes a 10 symbol identifying it as a Transport ADM and the text "192" identifies its capacity. Node icon 21 represents an access element, with the text "FCOT" identifying the element as a Fibre Central Office Terminal. Node icons 22,23 represent transport cross connect network elements.

15 Referring now to Figure 2b, a basic icon is shown which consists of a very thin rectangular green or light grey coloured icon used to represent a link. This will be referred to as a link icon. Links between two nodes are shown by link icons connecting the nodes and having a link type specifier 20 icon in the centre of the link icon. In Figure 2b only a segment of a link icon is shown. A link icon may consist of a series of segments which are arranged around other displayed icons so as not to interfere with them. Shown in Figure 2g are preferred link icon link representations for each of CNET 25 (control network) 30, optical fibre 32, and Electrical 34 type links. A more compact visual strategy may be employed when more than one link connects the same two nodes by using a single link bundle icon 36 instead of a series of individual link icons for the links. The four link icons described above 30 are intended to be used to convey state and status information as discussed in detail below.

For nodes which are shelf-based, consisting of a

number of cards, a node icon may be used to represent the entire node, or alternatively, a card icon representing each of the cards individually may be used. Referring now to Figure 2c, a basic icon is shown which consists of a light grey 5 coloured vertically oriented rectangular icon used to represent a card within a piece of shelf-based equipment. This will be referred to as a card icon. Typically, several card icons representing a set of cards within a piece of shelf-based equipment are shown together side by side to convey the fact 10 that they represent cards forming part of the same shelf. An example of this is shown in Figure 2d in which three card icons are displayed side by side. Using card icons instead of a node icon allows information for each card to be displayed independently.

15 The graphical representation may also include icons representing some of the components connected to the network which do not form part of the network. A simple pictorial icon may be used for these components. An example of a pictorial icon is given in Figure 3 which shows a pictorial icon 20 representing a terminal which may be a network management terminal, for example.

By way of example, Figure 4a shows the graphical representation of a very simple network which uses the above described basic icon shapes for nodes, and links. It includes 25 a pictorial icon 40 for a workstation terminal connected with a first CNET link icon 42 to a node icon 44 and a CNET link icon 46 to another node icon 52. The node icons 44,52 are for two network elements identified as switch cross connects by the symbol 12 from Figure 2e. Also shown are a node icon 54 for a 30 network element identified as a transport ADM by the symbol 14 from Figure 2e, and a symbolic node icon 56 for a coaxial node with link bundle icons 60,64 connecting these elements to node

icons 44, 52 respectively. The node icon 56 for the coaxial node is an example of a symbolic node icon having a different shape.

Depending on the complexity of a given network, the 5 graphical representation of the network may include only a subset of all of the objects in the network. There may still be too many objects in the network to be conveniently shown at one time in a graphical representation such as that shown in Figure 4a. In order to simplify the display of the overall 10 network, the objects may be grouped in various ways depending upon some user-defined criteria. The grouping of elements may be based on geographic and/or other administrative criteria, for example. Preferably flexible polygonal container icons are used to perform such a grouping function. An example of a 15 graphical representation of a network in which several container icons have been used to simplify the display of the network is given in Figure 4b. The graphical representation includes node icons 66, 67, 68, 70, link bundle icons 72, 73, 74, 75, 76, and container icons 79, 80, 81, 82. Each 20 container icon "contains" a collection of network object icons. A container icon may also contain other container icons in addition to the normal network object icons. Functionality may be provided to allow the specifics of what a container represents to be determined by opening the container. This 25 might expand the container icon to display the collection of network object icons or additional lower level container icons which it represents. Container icons may present information about themselves such as labels.

The shape of the container icon may be manipulated so 30 that it conforms to specific geographic or other administrative requirements or criteria. The container icons may be displayed transparently or translucently over a map of familiar geography

for improved recognition. Default flexible container colours are selectable by the network administrator. When they are created they are preferably translucent, having a muted colour such as grey-brown, grey-green, or grey-blue so as not to

5 conflict with any of the alarm colours, as discussed below. An example of this is shown in Figure 4c. Transparent container icons 90, 91, 92 are used to simplify or contain the portions of the network located in Oakland, San Francisco Bay, and Silicon Valley respectively. The container icons are

10 transparently displayed over a map of the relevant geographical area. Also shown are a number of small square node icons 93, 94, 95, 96 identified as transport nodes and links 97, 98, 99, 100, 101 connecting the transport nodes to each other and to the container icons. The use of container icons enables

15 improved partitioning of the network to match any particular requirements. Figure 4d shows an example of three polygonal containers labelled "Region A", "Region B" and "Region C" which have interlocking shapes which would be suitable to simplify the representation of non-overlapping groupings of network

20 objects. Transparency of the containers enables overlapping and meshed regions of the network. As an example of meshed regions of a graphical network representation, a first container icon may contain a first set of network object icons, a second container may contain a second set of network object

25 icons, and a third container may contain a set of network object icons which includes icons from each of the first and second sets. The complex relationships which exist in most of today's telecommunications networks often lend themselves to having their network objects grouped in various different

30 overlapping ways and the use of container icons improves a user's ability to understand these complex relationships and groupings.

In the management of networks, and particularly telecommunications networks, a state model is used to provide a top level view of the network. In any such model, each network object can be in one or more of a large number of states and 5 statuses. The states and statuses, and their definitions, and the allowed interactions between states are defined by each particular state model. The invention provides a graphical user interface which allows the visual depiction of very complex combinations of states. While the particulars of the 10 invention can be adapted in many ways to any specific state model, a preferred embodiment of the invention provides a graphical representation of network objects such as nodes, cards and links and their states and statuses as defined by the current OSI model.

15 In the visual language provided by the invention, each network object is represented by a basic icon as discussed above. Each basic icon representing a network object can be in one of a number of base states. These base states are indicated primarily by an attribute imparted to the basic icon 20 such as a different border, texture or perimeter. In addition, a set of modifier icons is provided which can be attached to the basic icon representing the network element to indicate supplementary state information. A modifier icon is an additional graphical symbol which is attached to or 25 superimposed over a portion of the basic icon. A conversion between the states and statuses specified by a given state model and the base states and supplementary states provided by the graphical representation preferably maps the more frequently occurring combinations of states or statuses from 30 the state model onto base states, and the less frequently occurring combinations of states or statuses onto supplementary states, thereby minimizing the required number of modifier

icons.

The OSI model currently includes three state types, and at any instant in time, each object of the network is in three OSI states simultaneously, one state from each of the 5 three state types. Each object has an Operational state which may be "Enabled" or "Disabled". Each object has a Usage state which may be "Busy", "Active" or "Idle". Each object has an Administrative state which may be "Unlocked", "Shutting down", or "Locked". The OSI states are summarized in the following 10 table:

State Type	States	Graphic Representation
Operational	Enabled	basic icon with imparted attributes
	Disabled	
Usage	Busy Active Idle	
Administrative	Unlocked Shutting Down Locked	basic icon with modifier icons superimposed

15

Each icon representing a network object is displayed in such a manner that the three OSI states of that object can instantly be discerned. This is done by imparting an attribute and in some cases a modifier icon to the basic icon which 20 reflects the OSI states. The preferred attributes and modifier icons imparted to the basic icon for the various state combinations are shown in Figures 5 and 6 for card icons and node icons. These same attributes and modifier icons are used with link icons, but these are not included in the Figures.

25 As shown in Figure 5, the OUA (Operational, Usage, Administrative state combination) of (Disabled, Idle, Unlocked) is indicated by imparting an attribute to the icon consisting

of a dashed border. The OUA of (Enabled, Idle, Unlocked) is indicated by imparting an attribute to the icon consisting of a solid border. The OUA of (Enabled, Active, Unlocked) is indicated by imparting an attribute to the icon consisting of a 5 three dimensional border.

The OUA of (Enabled, Busy, Unlocked) occurs less frequently and is represented by the icon having the three dimensional attribute in combination with a modifier icon consisting of a black exclamation mark as shown in Figure 6.

10 The "Busy" usage state is conveyed with a modifier icon and is thus a supplementary state.

Each of the OUAs in Figure 5 have an Administrative state of "Unlocked". The OUAs of (Disabled, Idle, Locked), (Enabled, Idle, Locked) and (Enabled, Active, Shutting Down) 15 are indicated by the addition of a lock modifier icon as shown in Figure 6. The Administrative state is conveyed through the use of modifier icons and is thus a supplementary state.

Combinations of OSI states which can be represented with icon attributes only, and without the requirement for any 20 modifier icons are the base states referred to previously. The base states in the above described graphical representation are shown in Figure 5 and consist of (Disabled, Idle, Unlocked), (Enabled, Idle, Unlocked), and (Enabled, Active, Unlocked). The particular graphical display attribute was chosen for each of 25 these base states to convey an intuitive visual semantic meaning. A dashed border attribute was selected for the base state of (Disabled, Idle, Unlocked) due to the visual semantics communicated by dashed lines, namely that of being disabled; a solid border attribute was selected for the base state of (Enabled, Idle, Unlocked); and a solid 3D border attribute was selected for the base state of (Enabled, Active, Unlocked) to 30 imply a "plump" node "full of activity or traffic". Since all

three base states have the administrative state "Unlocked" the base states in the remainder of the text will be referred to simply as (Disabled, Idle), (Enabled, Idle), and (Enabled, Active) for brevity.

5 Figure 7 shows the three base states for each of three types of network icon, namely a node icon, link icon, and card icon.

10 Referring back to Figure 4a, the three dimensional borders of node icons 50, 52, 54, 56 are indicative of the base state (Enabled, Active). Link icons 42, 46, 58, 60, 62, 64 also each have a three dimensional appearance indicative of the base state (Enabled, Active).

15 In addition to the three state types, the OSI model includes five status types, these being Alarm, Procedural, Availability, Control and Standby. The possible statuses for each status type are summarized in the following table:

Status Type	Statuses	Graphic Representation
Alarm	None Critical Major Minor Under Repair Outstanding or Acknowledged	basic icon with modifier icons superimposed
Procedural	None Initialization Required Not Initialized Initializing Reporting Terminating	
Availability	None (available) In Test Failed Power Off Off Line Off Duty Dependency Degraded Not Installed Log Full	
Control	None (unrestricted) Subject to Test Partly Locked Reserved to Test Suspended Standby Providing Service	
Standby	Providing Service Hot Standby Cold Standby	

Unlike the OSI states, a network object does not necessarily have a status from each status type, and in many cases will have no statuses at all. In the graphical representation of the network, which statuses of the five status types, if any, that apply to a given network object are

represented by modifier icons. Each modifier icon is intended to be a visual metaphor for the status it is representing. Note that in the OSI model, a given status may occur simultaneously with only certain combinations of states. In 5 the present context, this means that a given status may occur simultaneously with only certain base states. How modifier icons are used to represent the Procedural status, Availability status, Control status, and Standby status is illustrated in Figures 8 to 11 respectively. How the statuses illustrated in 10 Figures 8 to 11 may be combined is illustrated in Figures 12 to 15. How modifier icons are used to represent the Alarm status is illustrated in Figures 16 to 19.

It is noted that in the particular OSI implementation of the invention described herein, operational and usage states 15 are indicated by imparting attributes to the basic icon. Administrative states and all the OSI statuses are indicated using modifier icons superimposed on the basic icon graphic. As mentioned previously, the state and status information conveyed through the use of attributes is referred to herein as 20 base state information, and the state and status information conveyed through the use of modifier icons is referred to herein as supplementary state information. In this particular embodiment, the network management terminal receives the network management information initially in the form of OSI 25 state and status information and performs a state set conversion, converting the OSI states and statuses into base states and supplementary states for each network object. Once the base states and supplementary states for each network object have been determined, the attributes and modifier icons 30 which must be added to the basic icons are also known. More generally, an icon attribute may be used to display a base state selected from a set of base states, each base state

representing a state, a status or a combination of states and statuses, and modifier icons may be used to display a set of supplementary states, each supplementary state representing a state, a status or a combination of states and statuses. In 5 some cases it may be appropriate to map the network management information directly onto base states and supplementary states eliminating the requirement of performing a state set conversion.

Referring now to Figures 8 to 11, in each of the 10 illustrated examples, the modifier icon is shown as it might be applied to both a node icon and a card icon. Some textual description of the various statuses is also provided in the figures where appropriate.

Figure 8 shows how modifier icons may be used to 15 represent the Procedural status for each of the three base states. In the case in which there is no Procedural status, no modifier icon is required. The Procedural status "Initialization Required" can occur only for the base state (Disabled, Idle) and is represented by a modifier icon 20 consisting of a hand with an upward pointing solid triangle. A modifier icon consisting of three upward pointing solid triangles is used to represent the Procedural status "Initializing" for either of the base states (Disabled, Idle) or (Enabled, Idle). A modifier icon consisting of three 25 downward pointing solid triangles is used to represent the Procedural status "Terminating" for any of the three base states. A modifier icon consisting of two upward pointing triangles and a small bar graph is used to represent the Procedural status "Reporting" for either of the base states 30 (Enabled, Idle) and (Enabled, Active). In this example, the Procedural status is supplementary state information since it is displayed through the use of modifier icons.

Figure 9 shows how modifier icons may be used to represent the Availability status for each of the three base states. In the case in which there is no Availability status, no modifier icon is required. A bar graph modifier icon is 5 used to represent the Availability status "In Test" for the base state (Disabled, Idle). A broken stick modifier icon is used to represent the "Failed" Availability status for the base state (Disabled, Idle). An unplugged modifier icon is used to represent the Availability status "Power off" only for the 10 (Disabled, Idle) base state. A clock modifier icon is used to represent the "Off Duty" Availability status for the base states (Disabled, Idle) and (Enabled, Idle). To indicate the Availability status "Degraded" a grey exclamation point modifier icon is used for either of the base states 15 (Enabled, Idle) or (Enabled, Active). Recall that a black exclamation point modifier icon was used to indicate the usage state "Busy". Finally, the Availability status "Not Installed" is shown for the (Disabled, Idle) base state by adding hatch lines to the icon.

20 Figure 10 shows how modifier icons may be used to represent the Control status for each of the three base states. The "Subject to Test" Control status is represented by a bar graph modifier icon for each of the base states (Enabled, Idle) and (Enabled, Active). The "Reserved for Test" Control status 25 is represented for any of the three base states by a modifier icon consisting of a bar graph with a lock.

Figure 11 shows that modifier icons may be used to represent the Standby status for each of the three base states. A node which has a primary and a backup unit is illustrated by 30 two node icons one of which is behind the other. The icon in the foreground relates to the primary unit and may be referred to as a primary icon, while the icon in the background relates

to the backup unit and may be referred to as a backup icon. A card having a primary and a backup unit is indicated by a card icon with a pair of overlapping rectangles, namely a primary rectangle and a backup rectangle, symbolic of the redundancy.

5 For node icons, the status of the backup unit is indicated by the border of the backup icon. The Standby status can be either "Providing Service" which corresponds to the backup unit having a base state of (Enabled,Active) and is illustrated by a solid backup icon, "Hot Standby" which

10 corresponds to the backup unit having a base state of (Enabled,Idle) and is illustrated by the backup icon having a solid border, and "Cold Standby" which corresponds to the backup unit having a base state of (Disabled,Idle) and is illustrated by the backup icon having a dashed border.

15 For card icons, both rectangles being unshaded is indicative of "Cold Standby". The "Hot Standby" status is indicated by the primary rectangle having a shaded appearance with respect to the backup rectangle. The "Providing Service" status is indicated by switching the places of the two

20 rectangles, shading the backup rectangle black and by writing the symbol "2" within the backup rectangle to indicate that it is the backup card which is providing service.

There may be a need to show concurrent states or statuses. This can be achieved by listing the appropriate

25 modifier icons on the icon. Figure 12 shows several examples of this in row 160. Also shown in Figure 12 in row 162 is an alternative to showing a large number modifier icons, wherein an information modifier icon is used to draw the user's attention to a change in the state or status. By clicking on

30 the information icon, detailed information is then displayed.

In the above described embodiment, modifier icons are positioned at the top of the network node icons. This

positioning is somewhat arbitrary and could vary based on the particular object identified by the node icon according to any number of predetermined criteria. For example, they could be positioned so as to avoid overwriting the node identifier,

5 support more than one simultaneous icon, make the icons appear as separate and selectable objects, avoid overwriting the alarm count, or maintain some consistency with the alarm strategy.

Figure 13 shows an example of how modifier icons might be positioned on a link icon for a link in each of the 10 three base states. Two lock icons are shown indicating that the link has been administratively locked for both transmit and receive. Other positions for the modifier icons on link icons are possible.

Modifier icons can be positioned anywhere on a card 15 icon depending on the physical layout of the equipment. If the card has distinguishing characteristics such as lights, they should be shown on the icon in their correct position to give the craft and network operator a common reference point when they are communicating. As a result, modifier icons should 20 ideally be positioned in locations that would not obliterate these distinguishing characteristics. Figure 14 shows distinguishing characteristics at both the top 180 and bottom 182 of the card and also shows a series of modifier icons 184 on a card.

25 In some cases, it may be advantageous to make particular modifier icons selectable so as to provide access to further information. An example of this is shown in Figure 15 which includes a bar graph modifier icon indicative of the Availability status "In Test". The bar graph modifier icon is 30 selectable to provide access to a menu which in the illustrated case includes the options "Show details", "Open test manager", and "Hide Status".

Referring now to Figures 16 to 19, a comprehensive strategy for conveying detailed OSI alarm status information will be described. An alarm is an event status generated by a network object which may indicate that some sort of irregular 5 condition has occurred, and that test and repair work may be required. In the OSI model, there are alarm types having three different levels of severity. These OSI alarm severities are "Critical", "Major", and "Minor" and are abbreviated by the letters "C", "M" and "m" respectively.

10 Figure 12 shows modifier icons are used to represent the Alarm status for each of the three base states. A "New" alarm is an alarm for which no acknowledgement or action of any kind has been taken. The existence of New alarms is signalled by a bubble modifier icon with "abbreviated alarm text" written 15 therein indicating the number and the severity the New alarms. Abbreviated alarm text in the alarm bubble contains a count of the highest severity new alarms only. The bubble modifier icon and the basic icon are also coloured to draw attention to them, and to reflect the severity of the alarm, where the colours 20 yellow, orange and red are used to indicate increasing severities minor, major, and critical respectively. Thus a basic icon coloured orange with an orange bubble modifier icon with the abbreviated alarm text "1M" written therein means that one New Major alarm has occurred. The presence of one New 25 Major alarm is shown in Figure 12 for the (Enabled,Idle) 120 and (Enabled,Active) 122 base states for each of a card icon and a node icon. Note that the Figures are in black and white, and as such the colouring actually used to display alarms cannot be shown.

30 Once an alarm has been acknowledged, it becomes an Outstanding alarm rather than a New alarm. When there are no New alarms, the bubble modifier icon is removed, and the basic

icon including its border is recoloured its normal shades of grey. Outstanding alarms are indicated by the presence of an additional outline surrounding the border of the basic icon, with the colour of the additional outline matching the colour 5 associated with the severity of the highest-severity alarm. The outline is displayed so as not to interfere with the border already displayed. This allows the border and outline to convey different information. Abbreviated alarm text indicating a count of the highest severity alarms, both new and 10 outstanding, is written within the icon itself. An example of the appearance of the icon with one Outstanding Critical alarm 124,126,128 is shown in Figure 16 for each of the three base states. Each of the icons 124,126,128 has an additional red coloured (dark shade as illustrated) outline surrounding it and 15 has the text "1C" written within it indicating the presence of a single outstanding Critical alarm. There may be New and Outstanding alarms at the same time. In this case, the bubble modifier icon and the abbreviated alarm text in the bubble together with the colour of the bubble and basic icon 20 (including the border) will indicate the New alarms, and the outline surrounding the basic icon will indicate the highest severity of Outstanding alarms.

After an alarm has been acknowledged, and some repair work has been instigated, the alarm status "under repair" is 25 used to indicate this to be the case. The alarm status "Under Repair" is indicated by a "hand" modifier icon. When the hand modifier icon is applied, the additional outline surrounding the basic icon is removed assuming that no additional outstanding alarms exist.

30 In addition to the three OSI alarm severities of minor, major, and critical, the preferred embodiment of the invention includes two additional alarm severities, namely

"Warning" and "Unknown". A comprehensive display of how each severity of new alarm would appear on a container icon, a node icon, a link icon, and a card icon is shown in Figure 17. In each example, one alarm of the indicated severity is new, as

5 indicated by the bubble. The total number of the highest severity alarms is written within the icon. In this case, the total number is the same as the number of New alarms meaning that there are no outstanding alarms. In the case of container icons, the alarm indications reflect the sum of the most severe 10 of the alarms pertaining to the network objects contained by a given container icon. Thus, if four different network elements contained within a container each experienced one New Critical alarm, then the alarm bubble would contain the abbreviated alarm text "4C" indicating that the container has four new 15 Critical alarms.

The presence of additional alarms which have a severity lower than that of the highest severity is indicated by appending a "+" to the abbreviated alarm text. If the additional alarm is new, the "+" will be appended to the 20 abbreviated alarm text appearing in the bubble modifier and to the text appearing on the icon itself, while if the additional alarm is outstanding, then the "+" will only be appended to the abbreviated alarm text appearing on the icon itself.

As indicated above, an outstanding alarm is also 25 shown symbolically by adding an additional outline around the icon. Once the condition that caused an alarm is removed, for instance, once the corresponding fault is under repair, that alarm is no longer outstanding. When this occurs, the additional border around the icon is removed, and the 30 abbreviated alarm text is updated to reflect the new condition. Figure 18 illustrates in row 140 the appearance of several icons each having one outstanding critical alarm and at least

one outstanding alarms of lesser severity as indicated by the abbreviated alarm text "1C+" and the red (dark) border. In row 142 of Figure 18, similar icons are shown after the "under repair" modifier icon has been added.

5 Figure 19 illustrates a typical sequence of icon appearances for an example alarm scenario. First, a single new critical alarm occurring at a node is indicated by a red (dark) modifier icon bubble containing the text "1C" and by the basic icon being shaded red (dark) (A). Since the total number of 10 both New and Outstanding alarms is also one, the text "1C" also appears inside the node icon. The node has a base state of (Enabled,Active) as indicated by the three dimensional appearance of the icon. In (B), the alarm has been acknowledged and becomes an outstanding alarm. This is 15 indicated by the removal of the bubble icon modifier, by the red outline surrounding the node icon, and by the text "1C" remaining inside the node icon. The colour of the node icon has returned to normal, and the base state is still (Enabled,Active). In (C) the node is still in the base state 20 (Enabled,Active) but has the Administrative state "Shutting Down" as indicated by the lock modifier icon. In (D) the base state has changed to (Enabled,Idle) as indicated by the non-three-dimensional appearance of the icon. For this base state, the lock modifier icon signifies the Administrative state is 25 "Locked". In (E) the base state has changed to (Disabled,Idle) as indicated by the icon's border being dashed. In (F), the solid red outline has been removed indicating that the critical alarm is no longer outstanding. The hand modifier icon indicates that the network element has the Alarm status "Under 30 Repair". The abbreviated alarm text has been removed from the icon in this case. In (G) an additional modifier icon has been added to indicate the "In Test" Availability status.

In addition to the graphical representation of the alarms, Alarm manager window(s) may be provided which present a textual tabular summary of the alarms present on a particular set of network objects. Each network object included in the 5 table has a record which summarizes the alarms for that network object.

In the embodiment described above, exemplary base state icon attributes and supplementary state modifier icons have been used to represent all of the states, and a subset 10 of the statuses provided in the OSI model. Additional modifier icons (not shown) may be assigned to the remaining statuses so as to provide a complete graphic representation of the entire OSI model.

In Figure 20, a flowchart is shown of the logic 15 followed by the GUI in updating displayed state and status information when a change in a state or status occurs for any network object forming part of a network being graphically represented according to the invention. At step 0, it is assumed that the initial states and statuses of the network 20 objects are known. In step 1, a check is made to see if a change in a state or a status for any network object has occurred. If not, then no action is required. If a change for a specific network object has occurred, then in step 2 a check is made to see if that network object is included in an active 25 alarm manager window. If the network object is included in an active alarm manager window, then the record in the alarm manager window for that network object is updated to reflect the new state and status information. At this point, whether or not the basic icon for the specific network object is 30 displayed or not, the basic icon is defined as a "context symbol" in step 4. A basic icon is the first level of context symbol. A container icon containing a basic icon is the next

level of context symbol. A container containing a container is the next level of context symbol and so on. Steps 5, 6, and 7 are now repeated for the various levels of context symbol. In step 5, the context symbol which may be a basic icon or a 5 container icon, is updated with icon attributes and modifier icons to reflect the modified state and status information. Of course, in some cases, the particular context symbol may not be included in what is currently being displayed. For example, if the basic icon is within a container icon, then it will not be 10 displayed. However, the state and status information for the basic icon is still updated but with no immediate effect upon the graphical representation until the basic icon is actually displayed. In step 6, if the context symbol is not within a container, then the processing of that event finishes.

15 Otherwise, the container containing the context symbol is redefined as the context symbol, and steps 5,6,7 are repeated as necessary. Container icons include alarm information consisting of alarm modifier icons and text, but do not in general include the remaining state and status modifier icons 20 and attributes, these only being displayed on the relevant basic icon. The only difference in updating the alarm information for a container icon as opposed to a basic icon is that a container icon reflects the sum of the worst alarms outstanding for all of the basic icons or container icons 25 within it.

The initial graphical representation of the network is set up by a chief administrator using a GNE (Graphic Network Editor) screen which is used to define the position of network objects against their background. Normal users of the network 30 management tool access the GUI via a GNB (Graphic Network Browser). The GNE is used to make configuration changes as the network evolves and as network elements are added or removed.

A configuration of workstations to monitor a network using the GUI according to the invention will typically consist of at least one terminal, though for large networks a more typical application of the invention will have several workstations 5 running the GUI concurrently to allow many operators to share the effort of surveillance of the network. Whether on a single screen or multiple ones, the setup of the view presented to the operators is done by the chief administrator using the GNE.

The GNE provides the chief administrator with a basic 10 graphic editor (not unlike many PC drawing packages) and the following capabilities:

- provide a top level view GUI of the network;
- the ability to create sub levels of the top level to enable partitioning the nodes or containers representing the 15 network into logical sub groupings as required;
- import as many background images (such as maps of cities, countries or building floor plans) as will be required to provide a frame of reference in the various GUI levels;
- auto-discovery so that any new elements added to the 20 network pop up automatically in the top level of the GNE;
- auto-discovery may also include the automatic definition of the element type;
- the ability to create flexible containers in any of the levels in the GNE (the definition of the shape of these 25 containers being set by typical graphical editing techniques: clicking and dragging a mouse to define the shape on top of the background);
- the ability to drag and drop (via a mouse) network elements into containers and reposition the network elements to 30 meaningful locations against the background;
- the ability to assign a name (text label) to network elements and containers as well as assign names to each level

or window in the GUI;

- the ability to define how many GNB users there will be and for each user which views of the network GUI will be accessible;

5 - the basic set of GUI symbols and objects as defined by the invention with their associated attributes to represent network elements, links between elements and different containers.

Once the initial setup is made, the GNE's main 10 function is to (re)position network icons and container icons if the network is reconfigured in any way. For instance as new network objects are added and pop up in the GNE's top level view, they need to be situated in an appropriate location relative to the existing network object icons. Otherwise with 15 an unchanging network configuration, the GNB views are used to monitor the network and the GNE is likely inactive.

With the network configuration and views laid out by the GNE all users of the invention access the network management tool via their GNB windows. The layout and content 20 of windows and containers is not modifiable by users from the GNB. The GNB provides the user with a standard windows like means of navigating through the levels (to open or close or select which view to bring to the forefront or to "drag" and reposition a window on the workstation screen).

25 An example scenario using the network management GUI according to the invention running on a network management workstation equipped with the capabilities described above will now be described with reference to Figures 21a - 21f. In the example scenario which follows, a network is shown which is 30 still growing. A large amount of configuration activity is ongoing, and the network is experiencing some troubles.

Referring firstly to Figure 21a, shown is a top level

graphical representation of a network presented in a GNB (graphical network browser) window 200 on a display of the network management workstation. In this view, there are five regional container icons 201, 202, 204, 206, 208, labelled "Main", 5 "West", "South", "Centre" and "North" respectively. In this top level view, no individual network objects are shown. In the Main container icon 201, there is written the abbreviated alarm text "3m" 210. This indicates that there are three minor alarms which have occurred within this container. The fact 10 that there is no alarm bubble modifier icon signifies that the three minor alarms have all been acknowledged. A yellow outline 211 surrounds the border of container icon 201 also indicating the existence of acknowledged minor alarms.

In Figure 21b the Main container icon 201 is coloured 15 red, and a red bubble modifier icon 212 has been added containing the abbreviated alarm text "1M". This indicates that a new major alarm has been detected. The abbreviated alarm text within icon 201 has been updated to "1M+" where the "+" indicates that there are outstanding alarms of lesser severity 20 than major. The yellow outline 211 is also still shown. Also shown is an Alarm Manager window 214 which is displayed as a result of the operator double clicking on the alarm balloon 212. A single click would have produced a menu with a number 25 of items including the Alarm Manager. The Alarm Manager window 214 contains further details of the new major alarm. The operator decides to look at the network details, and does this by double clicking on the Main container icon 201 to open it.

In Figure 21c the GUI display after the operator has 30 double clicked on the Main container icon 201 is shown. A new window 216 titled "Main" displays the details of the network elements contained by the Main container icon 201. These include four nodes icons 220, 222, 224, 226 labelled "Main A",

"Main B", "Main C", and "Main D" respectively and several links icons connecting them. Now the particular node icon 220, Main A, which produced the alarms previously displayed in the top level view of Figures 21a and 21b is displayed in red along 5 with the red alarm balloon.

Additional information contained in the Main display window 216 shown in Figure 21c includes the fact that a link 230 connecting Main A to Main C has failed as indicated by its red dashed appearance. Modifier icons 232,234 are attached to 10 the Main D node icon 226 as a result of a previous operator action. These modifier icons 232,234 show that the node has been manually set to shut itself down, and is under repair respectively. Two nodes icons 236,238 are also shown which are in a "plan to add" state. These nodes have been installed, but 15 have yet to be configured as part of the network.

The next step in the scenario is for the operator to further investigate the source of the alarm. An operator can select a test to be run on the node which produced the alarm. In Figure 21d, the operator has selected node icon 220 and then 20 selected "Test 1" from a "Tests" menu. The effect of this is for an "in test" modifier icon 240 to be attached to the node icon 220 as shown in Figure 21e. When the test is complete, the modifier icon changes to inform the operator that this is the case. This may include an indication that physical repairs 25 are required. If physical repairs are required, then the operator can dispatch field personnel to complete them. When the repairs are completed, the equipment would then perform a self test to confirm normal operating conditions, and would report this to the network management workstation.

30 In Figure 21f, all of the equipment in the Main window has been restored to a normal state as indicated by the lack of any abnormal colours, modifier icons, outlines,

abbreviated alarm text etc. This completes the example scenario.

Numerous modifications and variations of the present invention are possible in light of the above teachings. It is 5 therefore to be understood that within the scope of the appended claims, the invention may be practised otherwise than as specifically described herein.

While a symbol set which includes ITU-T symbols has been used to identify network elements on the icons, 10 alternative symbol sets could be used, or the shape of the icon itself could be used.

While particular shapes for the node and link icons have been used in the illustrated and described examples, other shapes could be used with equal effect.

15 Modifier icons have been described which have particular shapes and positions, but clearly alternative shapes and positions could be used, so long as each modifier icon is clearly associated with a particular basic icon which represents a network object, and so long as the information 20 intended to be conveyed by the modifier icons is clearly visually discernable.

A particular strategy for dealing with alarms has been described in the preferred embodiment consisting of a combination of alarm bubble modifier icons, abbreviated alarm 25 text, shading the bubble and basic icon, and displaying outlines around the basic icon. While particularly appropriate for the OSI alarm states, this strategy could be applied equally well to other alarm state definitions. Alternative methods for representing this alarm information could also be 30 employed.

In some cases, information in addition to the state and status information needs to be made available to the

operator. The node icons may be expanded to a size appropriate for displaying the information required. An example of this is given in Figure 22. A basic node icon 300 for a transport node is shown, and further identified by its location in Toronto.

5 In order to identify the capacity of the transport node, expanded node icon 302 is used. Further details are given with node icon 304; where no expansion of the icon was required. In order to display performance statistics or traffic behaviour, for example, expanded node icon 306 may be used in which the 10 relevant graphical information is included within the boundaries of the expanded node icon. This provides a convenient way to map this additional information onto a physical view of the network in an easily comprehensible way.

Although the invention has been described as applied 15 in a particular way to represent the OSI standard, the scope of the invention includes other ways of representing the same OSI standard and other standards such as the BellCore requirements.

The primary and secondary states specified in the BellCore requirements are summarized in the following table:

Primary State		Primary State Qualifier	
IS	in service	NR ANR RST ANRST	normal abnormal restricted both ANR and RST
5	OOS	AU MA AUMA AURST MAANR	autonomous OOS management OOS both AU and MA AU and RST MA and ANR
Secondary State			
10	ACT	active	
	AINS	auto in service	
	BUSY	no spare capacity	
	COMB	sharing mate's load	
	DGN	diagnostic	
	EX	service affecting exercise	
15	FAF	supporting facility OOS	
	FEPO	far end processor OOS	
	FLT	faulty	
	IDLE	no users but ready	
	IDLERCV	connected to transmit but not to receive	
20	IDLETRMT	connected to receive but not to transmit	
	INHIP	inhibit in progress	
	LPBK	loopback in progress	
	MEA	mismatch of equipment and attributes	
	MON	reached abnormal threshold	
	MT	manual OSS for maintenance	
25	MTCLEIMD	maintenance limited due to defect	
	OVFL	overflow	
	PMI	performance monitoring inhibited	
	PPS	pre-post service	
30	PRI	protection release inhibited	
	PSE	protection switch exercise in progress	
	PWR	abnormal power condition	
	RAR	rearrangement in progress	
	RDLD	red lined	
35	SDEE	supported entity exists	
	SGEO	supporting entity outage	
	STBYC	cold standby	
	STBYH	hot standby	
	STBYI	standby inhibited	
	SWDL	software downloading	
40	SWTCH	switching system activity caused OOS	
	SWTI	software transfer inhibited	
	SWUL	software upload in progress	
	TRD	transferred load to mate	
	TRMB	terminate both	
45	TRMF	terminated from	
	TRMT	terminated to	
	TS	test in progress	
	UAS	unassigned	
	UEQ	unequipped	
50	WRK	working	

In applying the invention to the representation of the primary and secondary states of the BellCore standard, it would be preferred that the base states be used to represent the primary state information, and that modifier icons be used 5 to represent the secondary state information.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A processor implemented method for displaying information relating to a telecommunications network consisting of a plurality of network objects using a network management terminal having a display, the information consisting of a base state for at least one of the network objects, the method comprising the steps of:
  - 10 displaying on the display for each network object a basic icon corresponding to that network object; imparting to the display of each said at least one basic icon an attribute representative of the base state of the corresponding network object.
  - 15 2. The method according to claim 1 wherein each network object can be in combinations of states and statuses as defined by a network management model and wherein each base state represents a predetermined state, status, or a combination of states and statuses selected from the network management model.
  - 20 3. The method according to claim 1 further comprising the step of: adding to the display of each basic icon zero or more modifier icons selected from a predetermined set of possible modifier icons; wherein each modifier icon is representative of a different predetermined supplementary state.
  - 25 4. The method according to claim 3 wherein each network object can be in combinations of states and statuses defined by a network management model and wherein each base state and

supplementary state represents a predetermined state, status, or a combination of states and statuses selected from the network management model.

5 5. The method according to claim 1 wherein said attribute is selected from a predetermined set of attributes comprising a set of different icon borders.

10 6. The method according to claim 3 further comprising the step of adding text to the modifier icons to provide details of the supplementary state.

15 7. The method according to claim 3 wherein a different basic icon shape is used to represent each of three types of network objects, the three types being nodes, links and cards.

8. The method according to claim 7 wherein nodes are represented by a basic icon consisting of a square icon.

20 9. The method according to claim 7 wherein cards are represented by a basic icon consisting of a vertically oriented rectangular icon.

10. The method according to claim 7 wherein links are 25 represented by a basic icon consisting of a link icon having thin rectangular segments.

30 11. The method according to claim 4 wherein more commonly occurring state, status or state/status combinations are mapped onto base states, and less commonly occurring state, status or state/status combinations are mapped onto supplementary states.

12. The method according to claim 1 wherein symbols are used on each basic icon to identify the network object represented by that basic icon.

5 13. The method according to claim 1 further comprising the step of displaying at least one pictorial icon for a network object, the pictorial icon being devoid of any base state or supplementary state information.

10 14. The method according to claim 1 further comprising the step of selecting a group of said basic icons according to a predetermined criterion and displaying a single container icon representing the group of icons rather than displaying the group of icons individually.

15

15. The method according to claim 14 wherein the container icons are transparent or translucent and overlay a map displayed on the display.

20 16. The method according to claim 14 wherein the container icons each have a user definable shape.

17. The method according to claim 14 wherein the container icons are flexible and polygonal.

25

18. The method according to claim 14 wherein the container icons are imparted with icon attributes and modifier icons to reflect the base states and supplementary states of network objects represented by the container.

30

19. The method according to claim 14 wherein the container icons are expandable to display the icons in the

group of icons represented by the container icon.

20. The method according to claim 1 further comprising  
5 the steps of:

receiving network management information;  
converting the network management information into  
the base state for each said at least one network object.

10 21. The method according to claim 1 further comprising  
the step of expanding at least one basic icon to a larger size  
and displaying additional information on the icon.

15 22. The method according to claim 21 wherein the  
additional information is graphical.

23. The method according to claim 21 wherein the  
additional information is textual.

20 24. The method according to claim 4 wherein the states  
and statuses are a subset of those specified by the OSI  
standard.

25 25. The method according to claim 4 wherein the states  
and status are a subset of the primary states and the secondary  
states specified by the BellCore requirement.

26. A method for displaying OSI state and status  
information relating to a telecommunications network consisting  
30 of a plurality of network objects using a network management  
terminal having a display and processing means, the method  
comprising the steps of:

the processing means converting the OSI state and status information into base states and supplementary states for each network object;

the processing means displaying on the display for 5 each network object a basic icon representative of that network object, the basic icon being a node icon for a node network object, a card icon for a card network object, and a link icon for a link network object;

imparting to the display of at least one basic icon 10 at least one attribute selected from a predetermined set of possible attributes;

adding to the display of each basic icon zero or more modifier icons selected from a predetermined set of possible modifier icons;

15 wherein each attribute is representative of a different predetermined base state;

wherein each modifier icon is representative of a different predetermined supplementary state.

20 27. A method according to claim 26 wherein the node icon is a square icon, the card icon is a vertically oriented rectangular icon, and the link icon is an icon having thin rectangular segments.

25 28. A system for monitoring a telecommunications network consisting of a plurality of network objects, the system consisting of:

a network management terminal having a display and processing means;

30 means for conveying network management information from the network to the network management terminal;

wherein the processing means displays on the display

for each network object a basic icon representative of that network object;

wherein the processing means converts the network management information into a base state for each of at least 5 one network object;

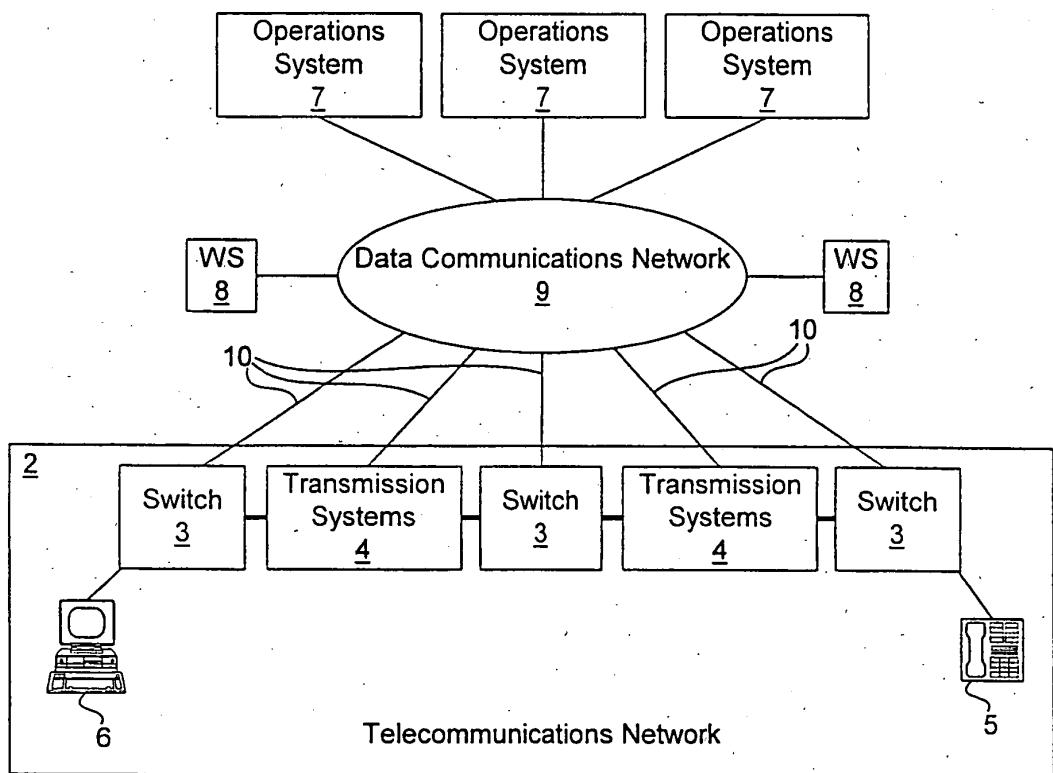
wherein the processing means imparts to each basic icon representative of said at least one network object at least one attribute selected from a predetermined set of possible attributes;

10 wherein each attribute is representative of a different predetermined base state.

29. The system according to claim 28 wherein the network management information consists of a state, status, or a 15 combination of states and statuses for each said at least one network object.

1/31

Fig. 1



SUBSTITUTE SHEET (RULE 26)

2/31

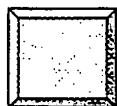


Fig. 2a

Fig. 2b



Fig. 2c



Fig. 3

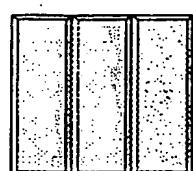
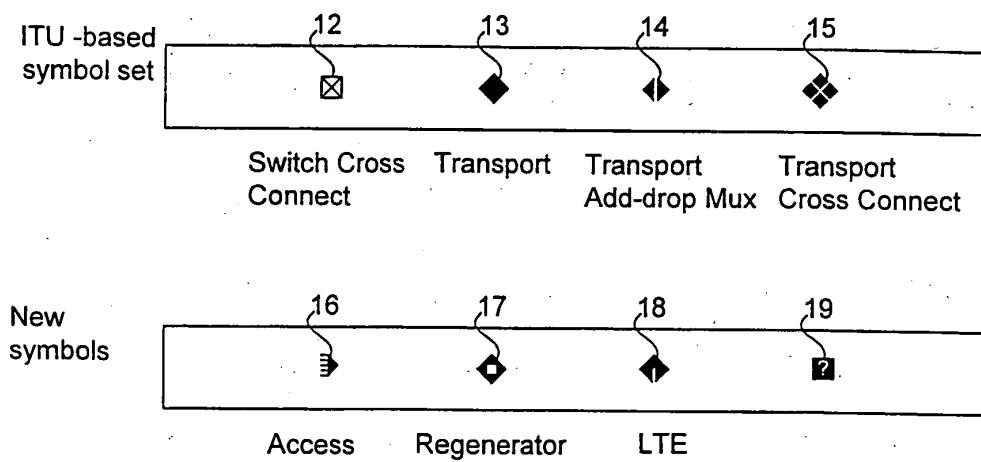


Fig. 2d

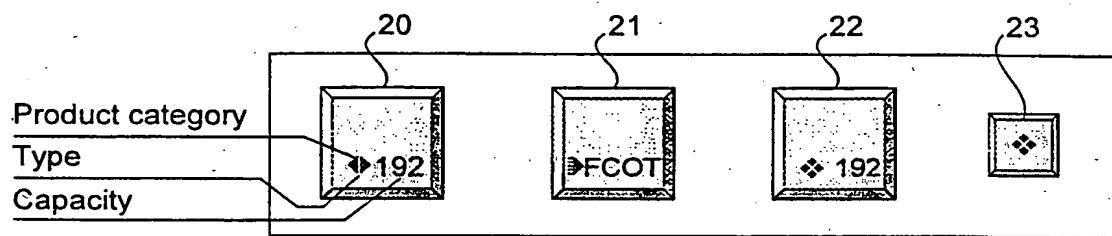
**SUBSTITUTE SHEET (RULE 26)**

Fig. 2e



4/31

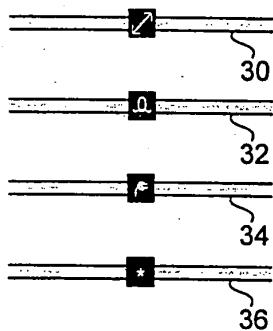
Fig. 2f



SUBSTITUTE SHEET (RULE 26)

5/31

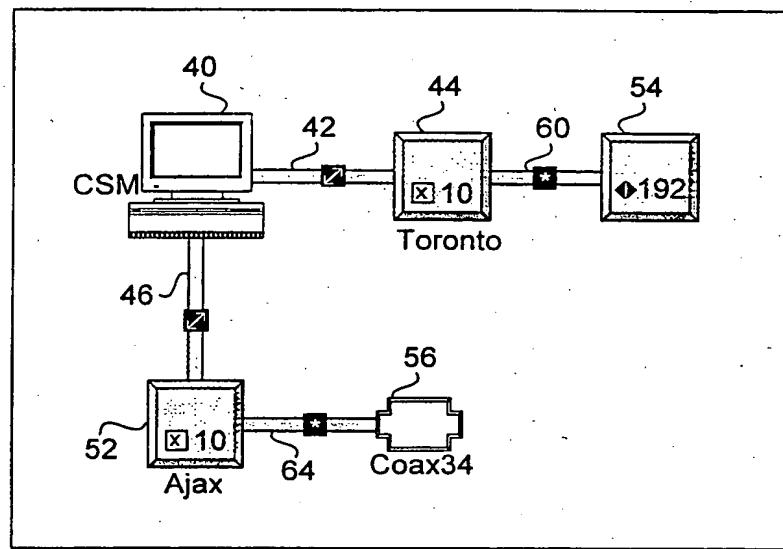
Fig. 2g



**SUBSTITUTE SHEET (RULE 26)**

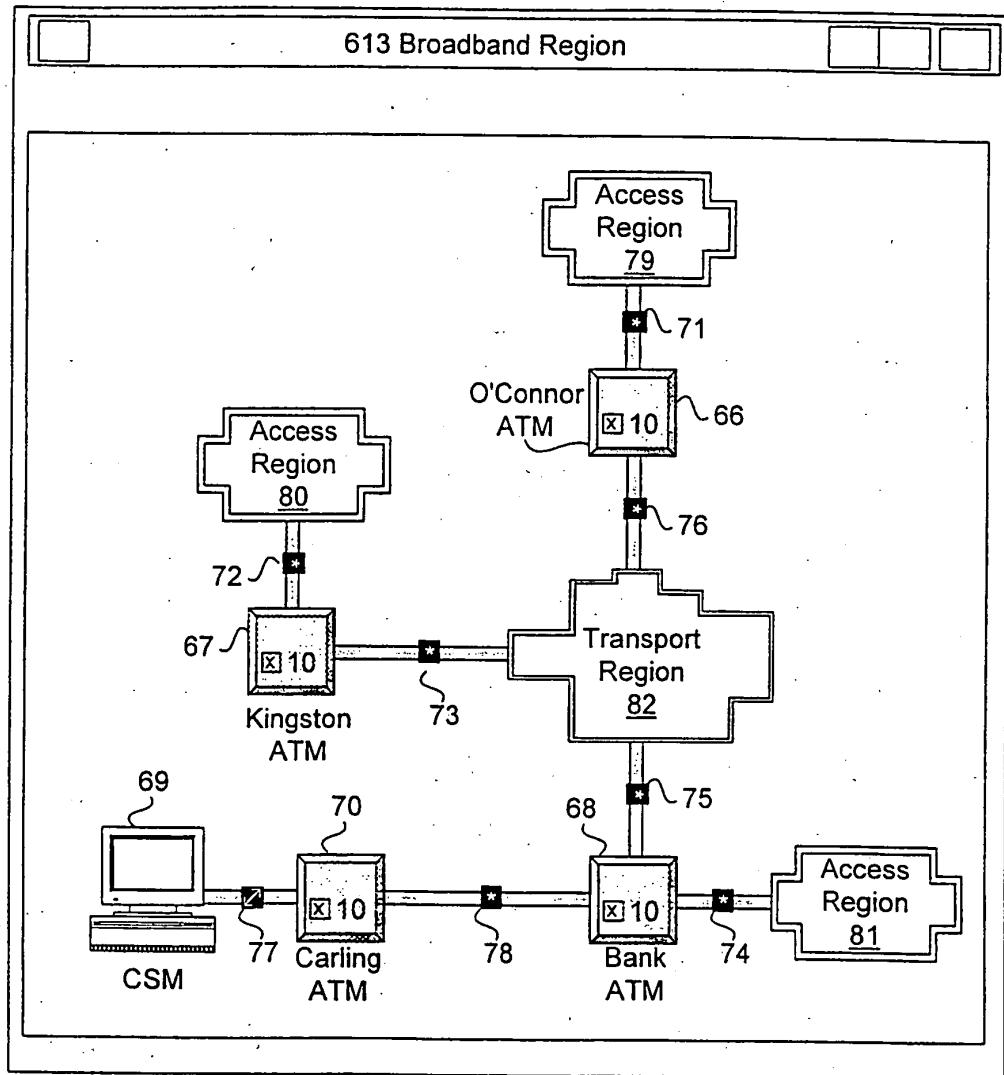
6/31

Fig. 4a



SUBSTITUTE SHEET (RULE 26)

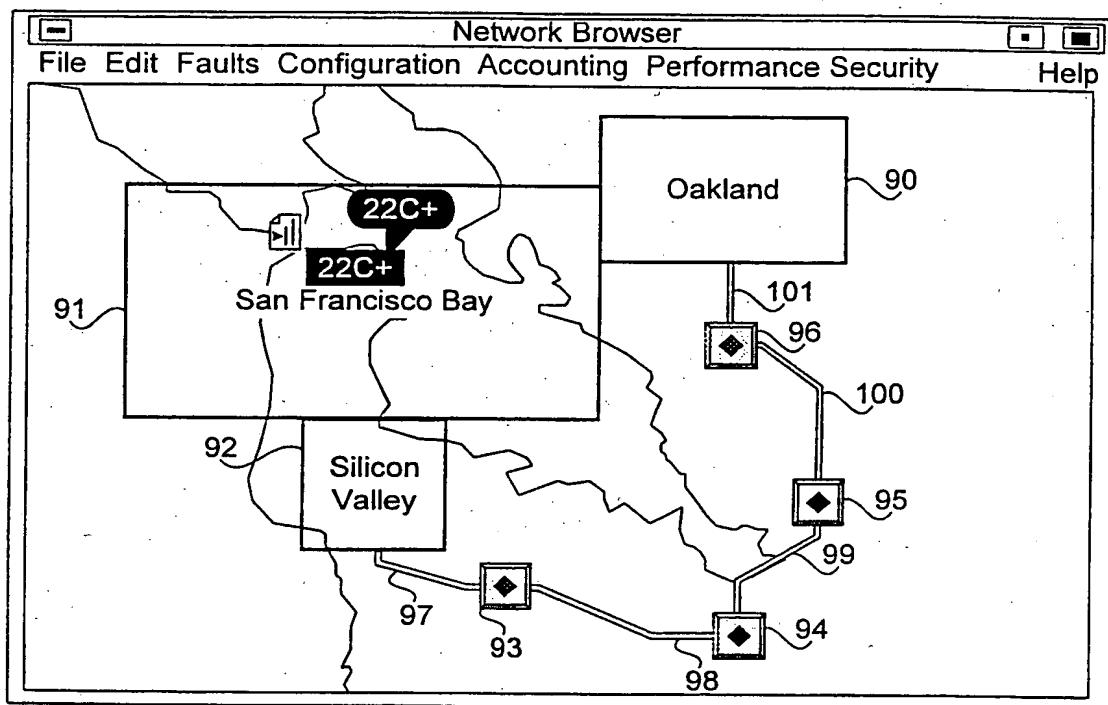
Fig. 4b



SUBSTITUTE SHEET (RULE 26)

8/31

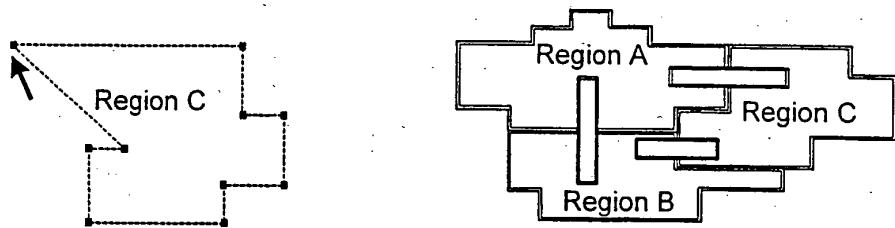
Fig. 4c



SUBSTITUTE SHEET (RULE 26)

9/31

Fig. 4d



**SUBSTITUTE SHEET (RULE 26)**

10/31

Fig. 5

OSI State Table

State or Status	Disabled, Idle	Enabled, Idle	Enabled, Active
<p><b>Default usage and operational states</b></p> <p>Disabled is represented by a dashed outline. Enabled, idle is represented by a solid outline. Enabled, active is represented by a 3D outline. In doing so, nodes, links and cards all use the same visual vocabulary.</p> <p>Additional administrative, procedural and control status is implied by the visual vocabulary and is listed in each table cell. As state or status changes, new icons are added to these base shapes.</p>	  <p>Disabled Idle Unlocked Not initialized Off line</p>	  <p>Enabled Idle Unlocked</p>	  <p>Enabled Active Unlocked</p>

SUBSTITUTE SHEET (RULE 26)

11/31

Fig. 6

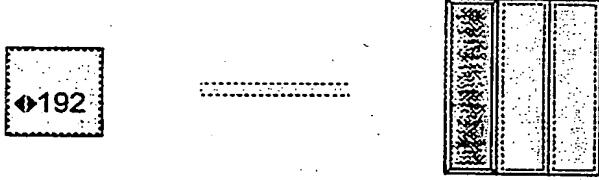
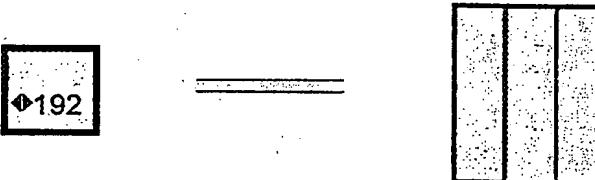
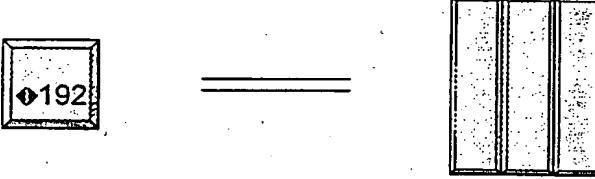
OSI State Table

State or status	Disabled, Idle	Enabled, Idle	Enabled, Active
<b>Usage states</b>			
Usages states include idle, active and busy.  Because network elements are frequently idle or active, these states have been represented as part of the default visual appearance of the object. See above.			 <b>Busy</b> The resource is in use with no spare capacity.
<b>Administratives states</b>			
Administrative states include locked, shutting down and unlocked	 <b>Locked</b> The resource is administratively prohibited from performing user services.	 <b>Locked</b> The resource is administratively prohibited from performing user services.	 <b>Shutting down</b> The resource is administratively permitted to existing instances of use only. The resource is shedding traffic.

SUBSTITUTE SHEET (RULE 26)

12/31

Fig. 7

OSI state combination	Node, link and card graphic treatment
Operation: Disabled Usage: Idle Administration: Unlocked	
Operation: Enabled Usage: Idle Administration: Unlocked	
Operation: Enabled Usage: Active Administration: Unlocked	

SUBSTITUTE SHEET (RULE 26)

Fig. 8

OSI State Table

State or Status	Disabled, Idle	Enabled, Idle	Enabled, Active
<b>Procedural Status</b>			
Initialization required			
Initializing			
Terminating			
Reporting According to the standard this usually implies test results are being returned.			

Fig. 9

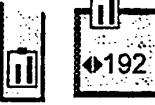
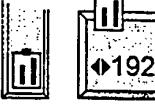
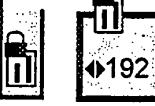
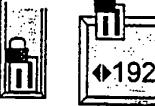
OSI State Table

State or status	Disabled, Idle	Enabled, Idle	Enabled, Active
<b>Availability status</b>			
In test			
Failed			
Power off			
Off duty			
Degraded			
Not installed			

15/31

Fig. 10

OSI State Table

State or status	Disabled, Idle	Enabled, Idle	Enabled, Active
<b>Control Status</b>			
Subject to test			
Reserved for test			

SUBSTITUTE SHEET (RULE 26)

16/31

Fig. 11

OSI State Table

State or status	Disabled, Idle	Enabled, Idle	Enabled, Active
<b>Standby status</b>			
Standby status includes cold standby, hot standby and providing service.	 	 	 
	<p><b>Cold standby</b> The resource is not providing service and cannot immediately take over the role of the primary resource.</p>	<p><b>Hot standby</b> The resource is not providing service but can immediately take over the role of the primary resource.</p>	<p><b>Providing service</b> A backup resource has been put into service. Applies only to backup resources.</p>

SUBSTITUTE SHEET (RULE 26)

Fig. 12

OSI State table

State or status	Disabled, Idle	Enabled, Idle	Enabled, Active
<b>Simultaneous state and status display</b>			
160 Across and within each status set (Control, Availability, etc.), there may be a need or desire to show concurrent status or states.	 	 	
The developer can display several states by listing the appropriate icons visually on the card or node.	Operational: Disabled Usage: Idle Admin: Locked Availability: In test	Operational: Enabled Usage: Idle Admin: Locked Control: Reserve for test Procedure: Reporting	
162 As an alternative to showing too many states on a card, link or node, the developer may optionally use the information icon to draw a user's attention to a change in state or status.	 	 	 
The state or status details could then be displayed in a popup or window that can be accessed by clicking on the information icon. One possible example is shown at right.	<div style="border: 1px solid black; padding: 10px; width: fit-content; margin: 0 auto;">           Operation: Item            Usage: Item            Admin: Item            Procedural: Item, item            Control: Item, item            Availability: Item, item         </div> 		

18/31

Fig. 13

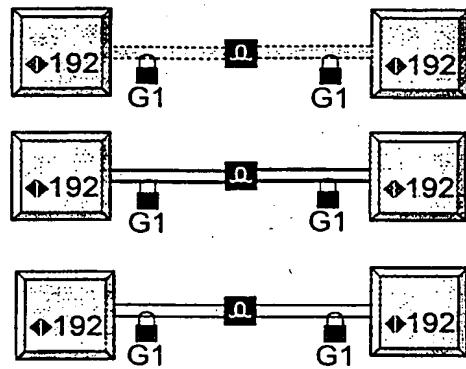
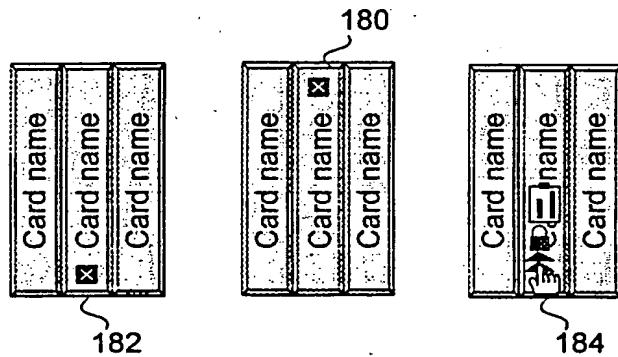


Fig. 14



SUBSTITUTE SHEET (RULE 26)

Fig. 15

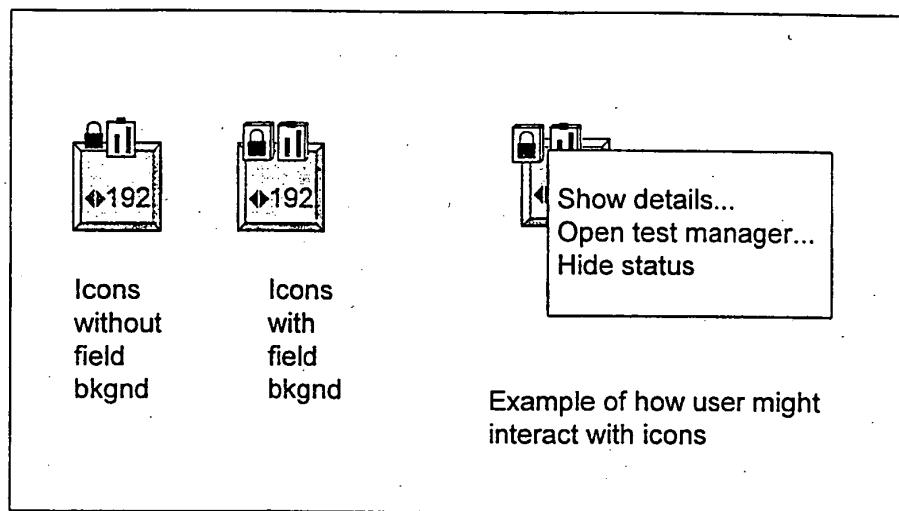


Fig. 16

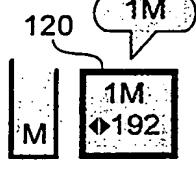
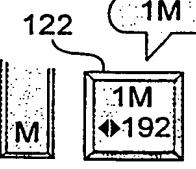
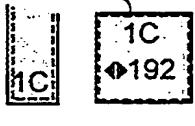
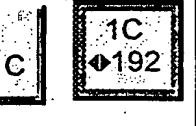
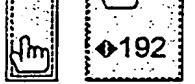
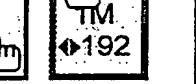
Alarm status			
New alarms		120 	122 
New alarms are shown by displaying an alarm bubble with the new alarm count (1M). Totals are shown inside the node. The examples shows a new Major alarm is shown as an example; see section on alarm strategy for more details.		 1M ◆192	 1M ◆192
Outstanding alarms	124 	126 	128 
The example show a critical alarm acknowledged; see section on alarm strategy for more details.	 1C ◆192	 1C ◆192	 1C ◆192
Under repair	 M ◆192	 M ◆192	 M ◆192
The examples show no new or outstanding alarms. The acknowledge alarm visual could also be visible.	 M ◆192	 M ◆192	 M ◆192

Fig. 17

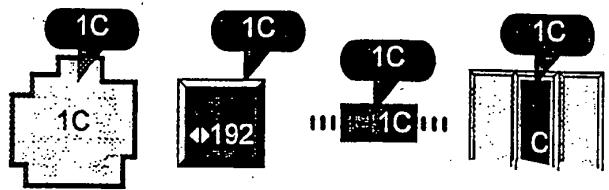
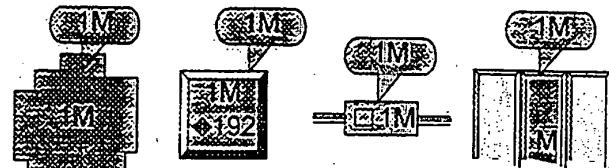
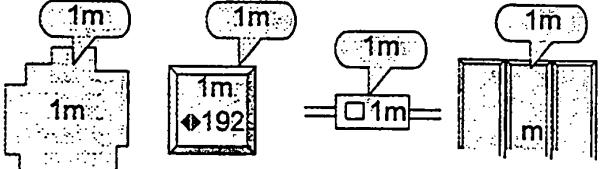
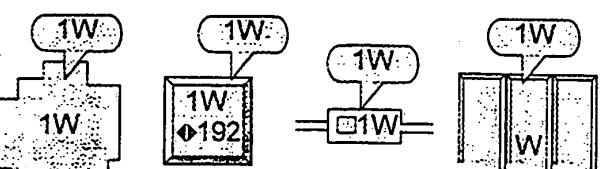
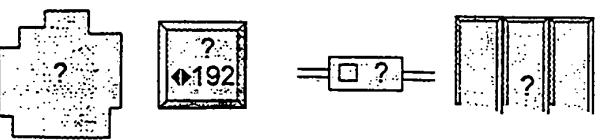
Status	Region, node, link, and shelf graphic
<b>Critical alarm (OSI)</b> New alarms are shown by displaying an alarm bubble with the new alarm count. Total of all new or outstanding alarms are contained in the element.	
<b>Major alarm (OSI)</b> New alarms are shown by displaying an alarm bubble with the new alarm count. Total of all new or outstanding alarms are contained in the element.	
<b>Minor alarm (OSI)</b> New alarms are shown by displaying an alarm bubble with the new alarm count. Total of all new or outstanding alarms are contained in the element.	
<b>Warning alarm</b> New alarms are shown by displaying an alarm bubble with the new alarm count. Total of all new or outstanding alarms are contained in the element.	
<b>Unknown status (OSI)</b> <b>Loss of connectivity</b> While not a true alarm state, it is such a serious condition that it is included in this visual strategy.	

Fig. 18

Status	Region, node, link and shelf graphic
Outstanding alarm (OSI) Acknowledged alarm  The example shows one outstanding critical alarm (1C) and a number of other outstanding lower level alarms (+).	
Under repair (OSI)  The hand icon represents under repair. The alarm count would not necessarily be displayed and the state would not be necessarily be "enabled and active".	

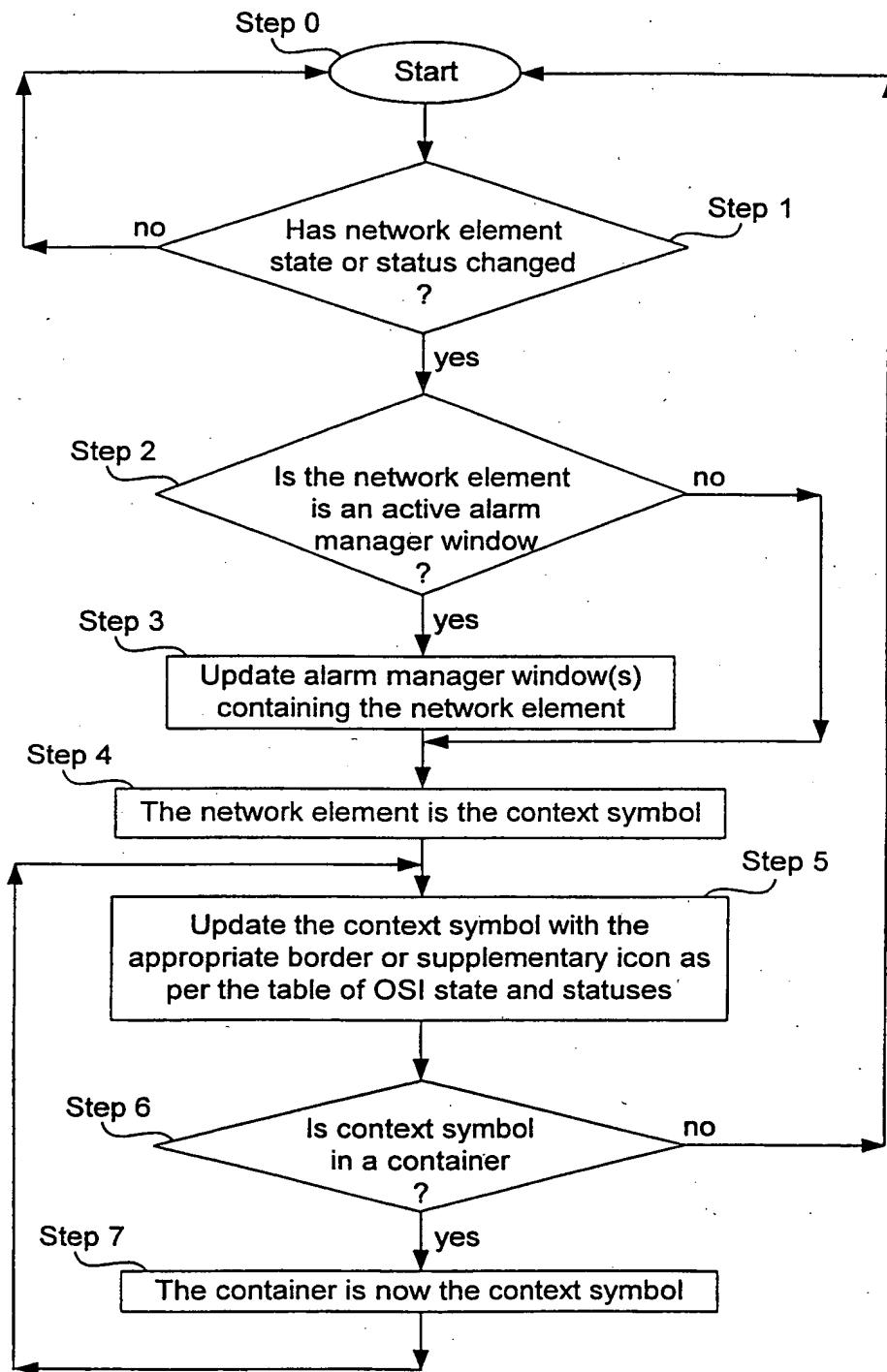
23/31

Fig. 19

A		Operational/usage: Enabled, Active Administrative: Unlocked Availability: Alarm status: New alarm
B		Operational/usage: Enabled, Active Administrative: Unlocked Availability: Alarm status: Outstanding
C		Operational/usage: Enabled, Active Administrative: Shutting down Availability: Alarm status: Outstanding
D		Operational/usage: Enabled, Idle Administrative: Locked Availability: Alarm status: Outstanding
E		Operational/usage: Disabled, Idle Administrative: Locked Availability: Alarm status: Outstanding
F		Operational/usage: Disabled, Idle Administrative: Locked Availability: Alarm status: Under repair
G		Operational/usage: Disabled, Idle Administrative: Locked Availability: In test Alarm status: Under repair

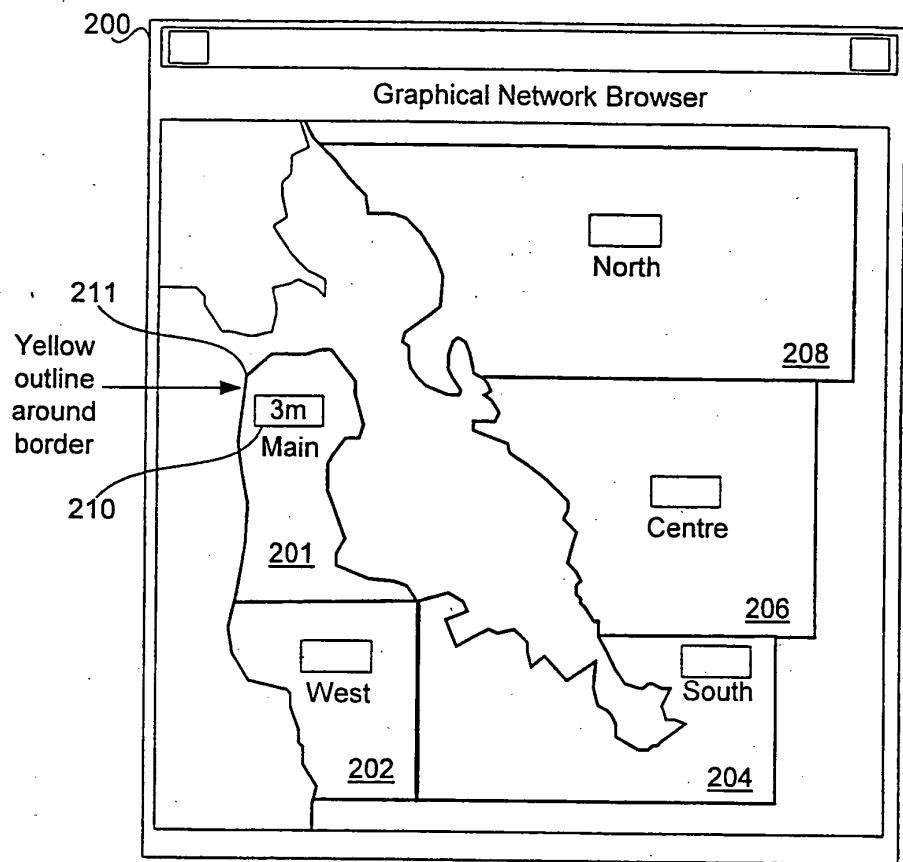
SUBSTITUTE SHEET (RULE 26)

Fig. 20



SUBSTITUTE SHEET (RULE 26)

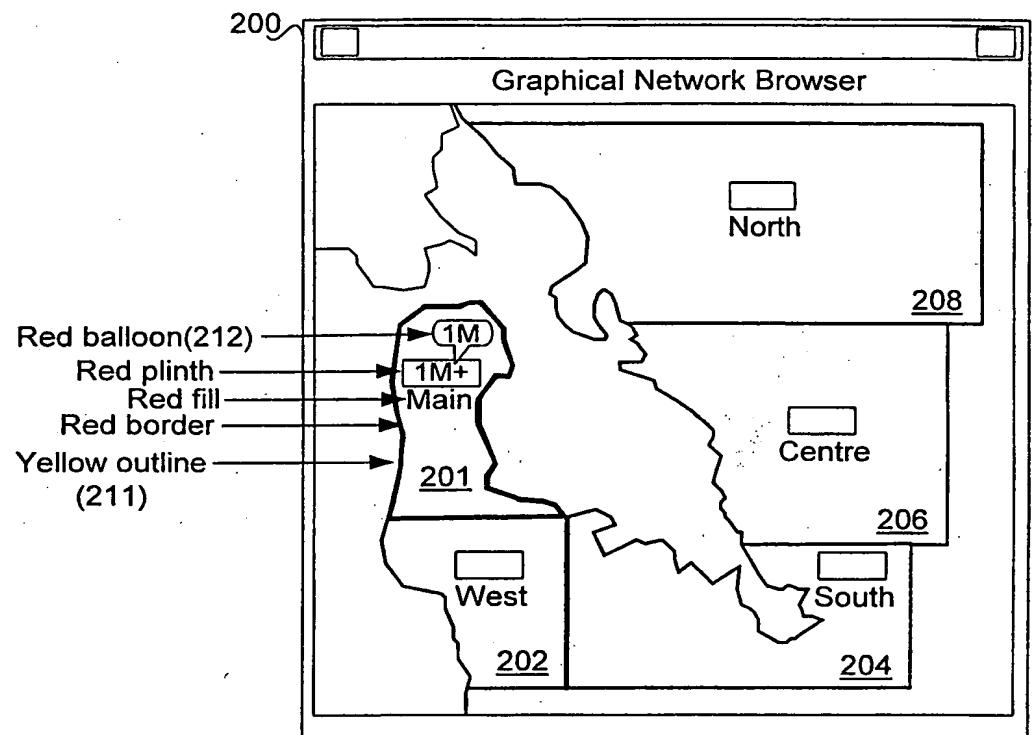
Fig. 21a



SUBSTITUTE SHEET (RULE 26)

26/31

Fig. 21b



214

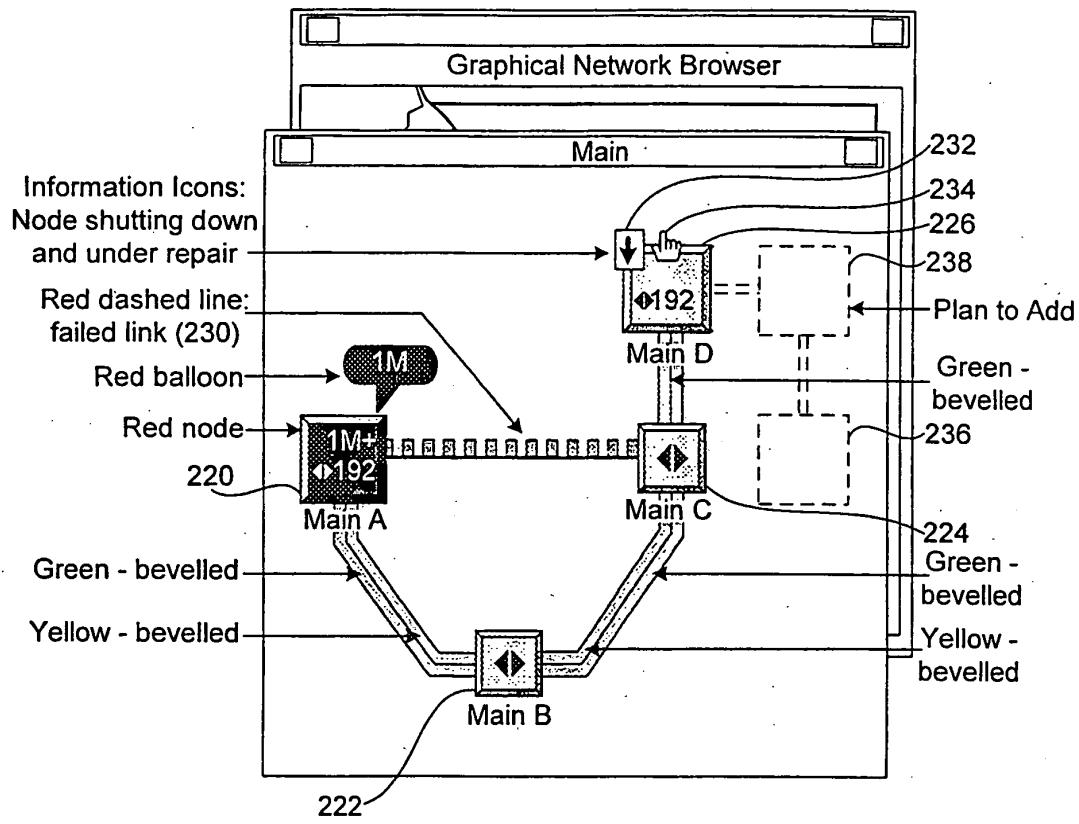
Alarm manager

Network Element	Alarm	Class	Unit	Reason	Time	Severity
Main A	4	Fac	DS3	G1-1 Rx loss	18 Aug 96 18:49:26	Major SA
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

Display Options:  Auto  Showing  Critical  Major  minor  warnings  
 threshold crossings

List Options Details of Selected Alarm

Fig. 21c



214

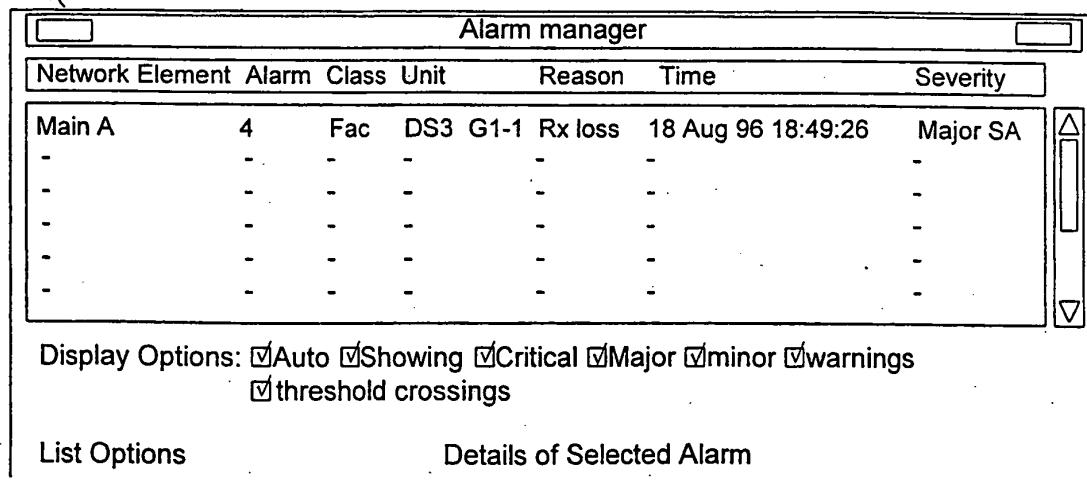


Fig. 21d

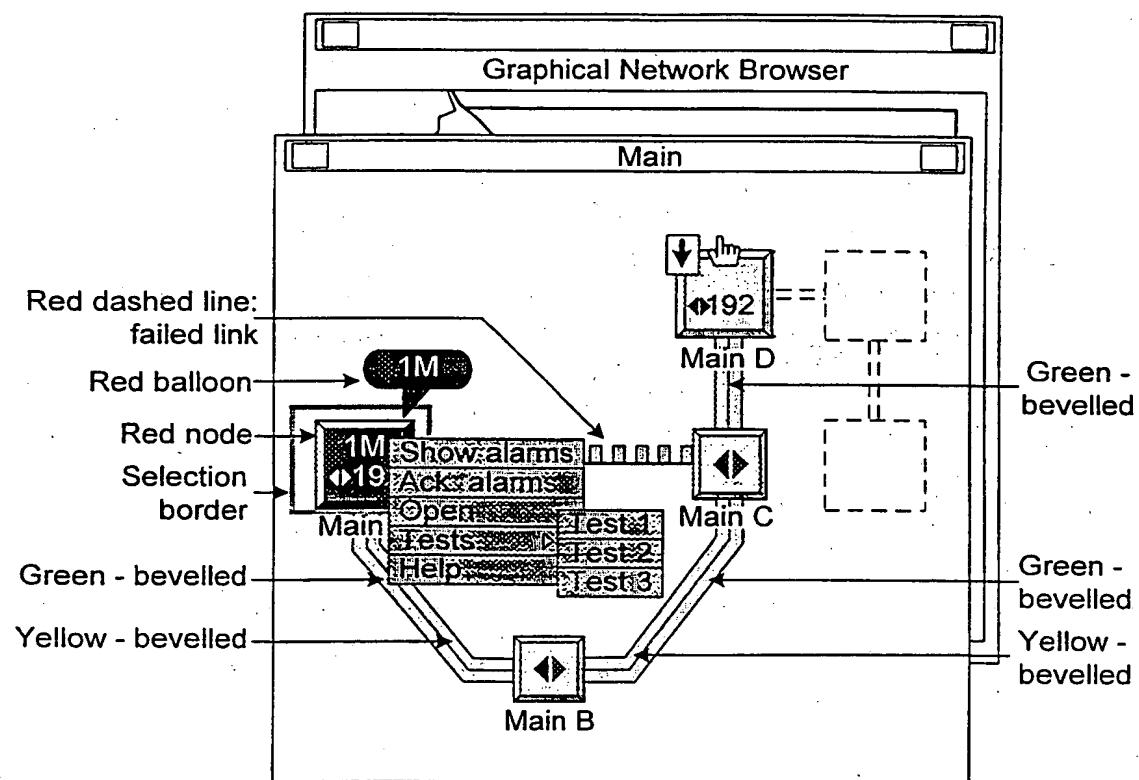


Fig. 21e

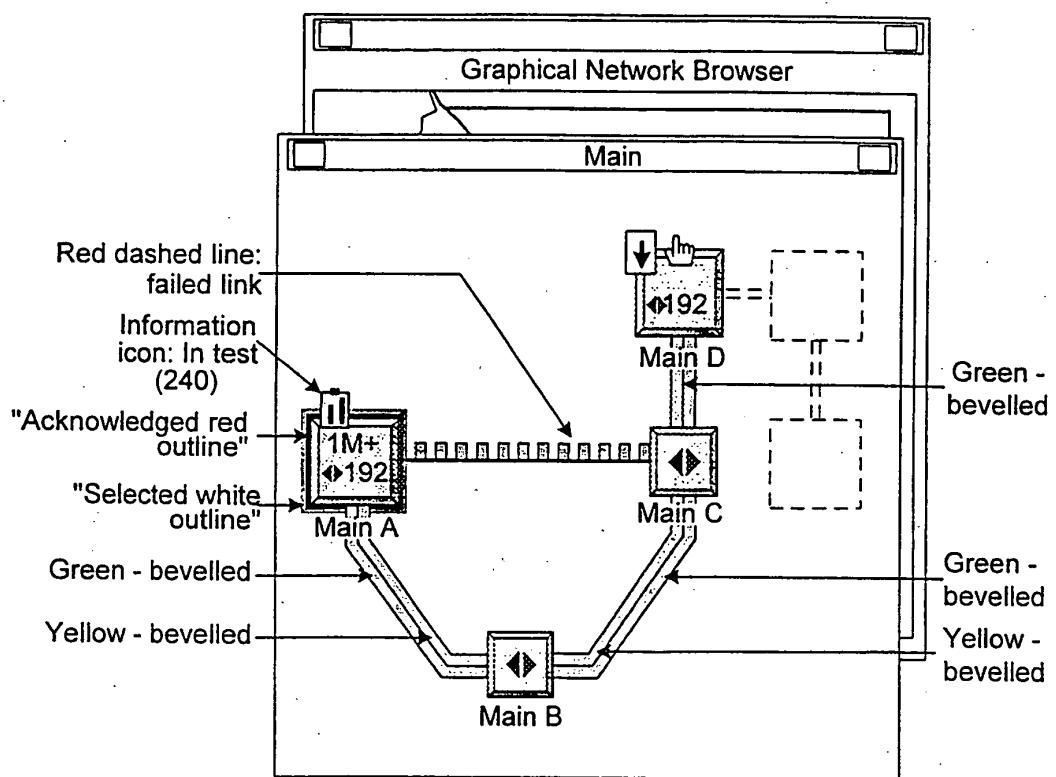
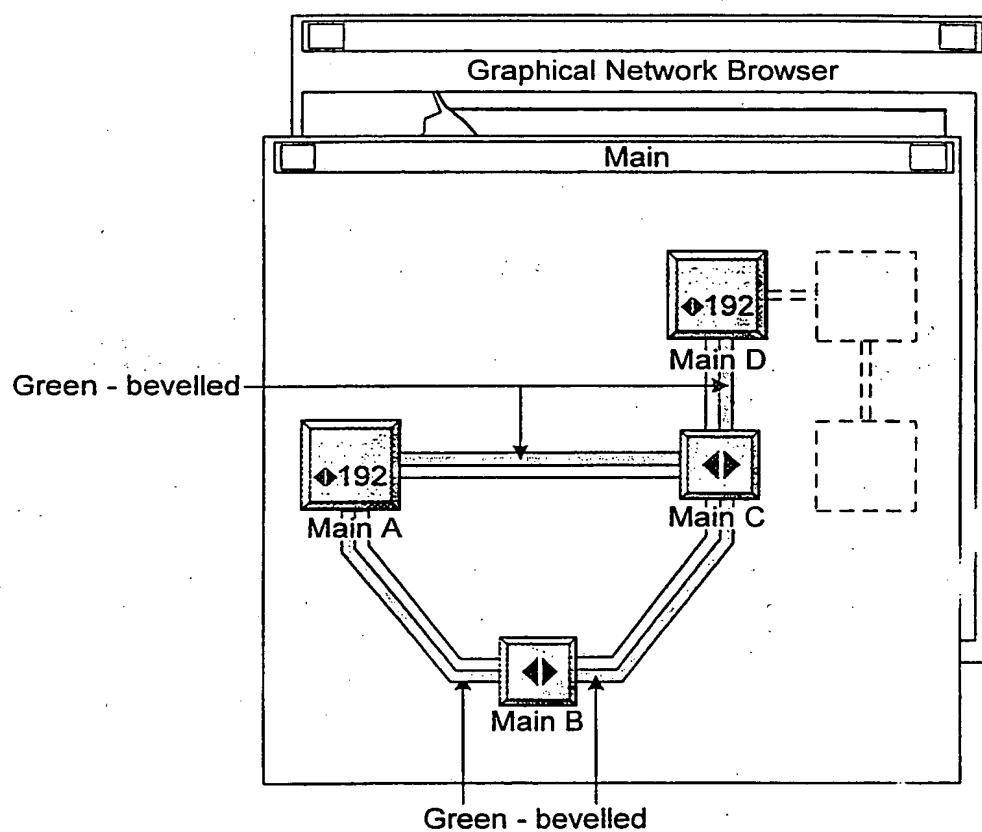


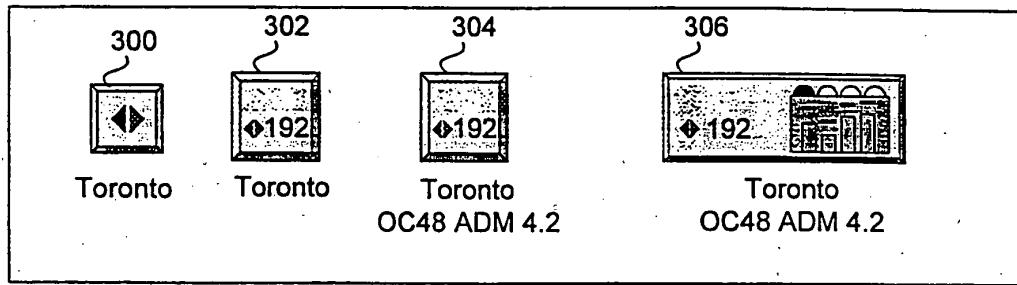
Fig. 21f



SUBSTITUTE SHEET (RULE 26)

31/31

Fig. 22



**SUBSTITUTE SHEET (RULE 26)**

# INTERNATIONAL SEARCH REPORT

Inte onal Application No  
PCT/CA 97/00953

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 H04L12/24

According to International Patent Classification(IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 H04L G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	-/-	

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 March 1998	17/03/1998
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl. Fax: (+31-70) 340-3016	Authorized officer  <b>Larcinese, C</b>

Form PCT/ISA/210 (second sheet) (July 1992)

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/CA 97/00953

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>SMITH C J ET AL: "HP OPEN VIEW WINDOWS: A USER INTERFACE FOR NETWORK MANAGEMENT SOLUTIONS"          HEWLETT-PACKARD JOURNAL,          vol. 41, no. 2, 1 April 1990,          pages 60-65, XP000116175          see page 60, left-hand column, line 1 - line 7          see page 60, right-hand column, line 13 - page 61, left-hand column, line 2          see page 61, left-hand column, line 11 - line 18          see page 61, right-hand column, line 36 - line 56          see page 63, left-hand column, line 1 - line 6          see page 63, right-hand column, line 9 - line 22          see page 65, left-hand column, line 30 - line 61</p> <p>---</p>	1,2,12, 26,28
X	<p>WO 93 10495 A (CABLETRON SYSTEMS INC) 27 May 1993          see abstract          see page 5, line 16 - line 25          see page 7, line 17 - line 24          see page 11, line 1 - line 18          see page 13, line 7 - line 16          see page 16, line 18 - line 20          see page 31, line 13 - page 32, line 23          see page 33, line 1 - line 13          see page 36, line 21 - page 37, line 6</p> <p>---</p>	1
A		2,26,28
A	<p>US 5 535 403 A (LI ET AL) 9 July 1996          see abstract          see column 1, line 21 - line 27          see column 2, line 6 - line 19          see column 2, line 33 - line 47          see column 3, line 32 - line 38</p> <p>---</p>	1-29
A	<p>US 5 471 399 A (TANAKA ET AL.) 28 November 1995          see abstract          see column 1, line 29 - line 34          see column 2, line 23 - line 41</p> <p>---</p>	1-29
A	<p>EP 0 540 925 A (IBM CORPORATION) 12 May 1993          see abstract          see column 2, line 12 - line 25</p> <p>----</p>	1-29

1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No  
PCT/CA 97/00953

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9310495 A	27-05-93	AU 3145093 A US 5559955 A	15-06-93 24-09-96
US 5535403 A	09-07-96	JP 2548899 B JP 6348621 A	30-10-96 22-12-94
US 5471399 A	28-11-95	JP 5056043 A	05-03-93
EP 540925 A	12-05-93	CA 2081180 A JP 2102132 C JP 5216610 A JP 8023803 B	01-05-93 22-10-96 27-08-93 06-03-96

Form PCT/ISA/210 (patent family annex) (July 1992)

**THIS PAGE BLANK (USPTO)**